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National Dioxin Study: Tiers 3, 5, 6, and 7

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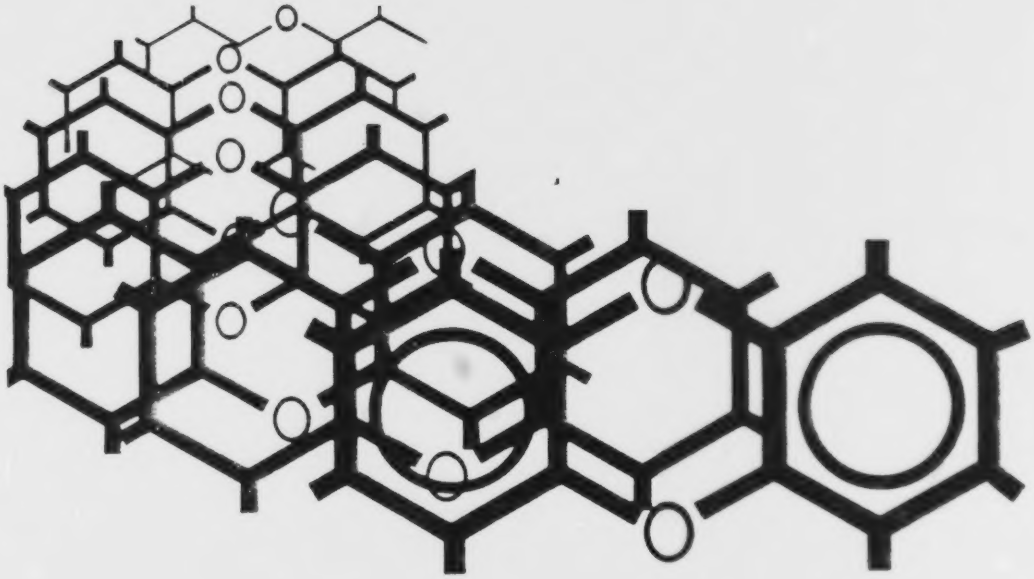
The National Dioxin Study

Tiers 3,5,6, and 7



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16. Abstract (Limit: 200 words)

This report contains the results of an investigation by the U.S. Environmental Protection Agency to determine the extent of 2,3,7,8-tetrachlorodibenzo-p-dioxin (2,3,7,8-TCDD) contamination in the environment. The report presents the findings and conclusions from four of the seven tiers (Tiers 3,5,6, and 7). These four tiers are: Tier 3 sites where 2,4,5-trichlorophenol (2,4,5-TCP) or its derivatives were formulated, blended, and packaged. Tier 5 sites where suspected contaminated pesticides were commercially applied; Tier 6 sites where certain other chemical processes could inadvertently form 2,3,7,8-TCDD; and Tier 7 background soil and fish sites.

More than 4,000 samples from 862 sites nation-wide were collected and analyzed for this investigation. Sampled media included soil, sediment, fish, and various animal and plant tissues. This report also presents discussions of the environmental fate processes and health assessments related to 2,3,7,8-TCDD exposure. Finally, the report describes the quality assurance program implemented to meet the objectives of the study.

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THE NATIONAL DIOXIN STUDY

Tiers 3, 5, 6, and 7

U.S. Environmental Protection Agency
Office of Water Regulations and Standards
Monitoring and Data Support Division
401 M Street, S.W.
Washington, D.C. 20460

February 1987

TABLE OF CONTENTS

1.0 EXECUTIVE SUMMARY.................................... v

1.1 Background.. v

1.2 Levels of Concern................................... v

1.3 Findings and Conclusions............................ vi

1.4 Accomplishments..................................... viii

2.0 INTRODUCTION.. 1

3.0 DESCRIPTION OF THE NATIONAL DIOXIN STUDY............ 4

3.1 Objective... 4

3.2 Approach.. 4

4.0 IMPLEMENTATION AND RESULTS OF THE STUDY............. 9

4.1 Tier 3.. 9

4.2 Tier 5.. 26

4.3 Tier 6.. 37

4.4 Tier 7.. 46

5.0 QUALITY ASSURANCE/QUALITY CONTROL................... 57

5.1 Introduction.. 57

5.2 Overall Approach to Quality Assurance............... 57

5.3 Data Quality Objectives............................. 62

5.4 Estimates of Data Quality........................... 64

6.0 REFERENCES.. 72

APPENDICES

Appendix A - Health Assessments for TCDD.................... A-1

Appendix B - Fate of 2,3,7,8-TCDD in Soil.................... B-1

Appendix C - Estimation Procedures and Results............... C-1

Appendix D - Analytical Data................................. D-1

FIGURES

Figure 1-1 Locations of Sampled Tier 3 Sites................. vii
1-2 Locations of Sampled Tier 5 Sites................. viii
1-3 Locations of Sampled Tier 6 Sites................. ix
1-4 Locations of Sampled Tier 7 Soil Sites............ x
1-5 Locations of Sampled Tier 7 Fish and Shellfish Sites.................................... xi
3-1 Activities and Data Flow in the National Dioxin Study............................ 5
4-1 Distribution of Contamination at Tier 3 Sites..... 14
4-2 Distribution of Soil Samples at Contaminated Tier 3 Sites.................................. 16
4-3 Distribution of Sampled Tier 3 Sites by Chemical Handled................................ 18
4-4 Distribution of Contamination at Tier 6 Sites..... 42
4-5 Distribution of 2,3,7,8-TCDD Concentrations in Fish (Maximum Level at Each Site)........... 51
4-6 Comparison of 2,3,7,8-TCDD in Whole Fish and Filets at Background Sites..................... 53

TABLES

Table 4-1 Statistically Selected Tier 3 Sites That Were Ineligible............................ 11
4-2 Statistically Selected Tier 3 Sites That Could Not Be Sampled...................... 13
4-3 Tier 5 Site Characterization...................... 28
4-4 Tier 6 Compounds and Number of Sampled Sites..... 38
4-5 Statistically Selected Tier 6 That Were Ineligible............................ 41
4-6 Statistically Selected Tier 7 Fish Sites That Could Not be Sampled........... 49
4-7 Summary of Industrial Discharges at Tier 7 Fish Sites............................. 54
5-1 Quantitative Objectives for 2,3,7,8-TCDD Analyses.. 65
5-2 Summary of Precision Statistics.................. 69
5-3 Summary of Bias Statistics........................ 70

1.0 EXECUTIVE SUMMARY

1.1 Background

As part of its Dioxin Strategy, the U.S. Environmental Protection Agency (EPA) conducted the National Dioxin Study, an investigation to determine the extent of 2,3,7,8-tetrachlorodibenzo-*p*-dioxin (2,3,7,8-TCDD) contamination in the environment. This report presents the findings and conclusions from the sampling efforts conducted for four of the seven tiers (Tiers 3, 5, 6, and 7) defined in the Dioxin Strategy. The EPA defined these four tiers as follows:

Tier 3 -	Formulators, blenders, and packagers of 2,4,5-trichlorophenol (2,4,5-TCP)-based pesticides;
Tier 5 -	Sites where suspected contaminated pesticides were commercially applied;
Tier 6 -	Other chemical producers with a lower potential for contamination; and
Tier 7 -	Background sites.

This report also discusses the environmental fate processes and health assessments related to 2,3,7,8-TCDD which can be useful in interpreting the results of the study. Finally, the report describes the quality assurance program implemented to ensure that the quality of the data would be sufficient to meet the objectives of the study.

1.2 Levels of Concern

Three federal agencies (the Environmental Protection Agency - EPA, the Food and Drug Administration - FDA, and the Centers for Disease Control - CDC) have established at various times levels of concern for 2,3,7,8-TCDD in different media (see Appendix A for a detailed discussion). The EPA has published a water quality criteria document that reports an estimated increased lifetime cancer risk of 1 in a million from drinking water and eating fish from waters containing 0.013 part per quadrillion (ppq) of 2,3,7,8-TCDD. Applying the fish bioconcentration factor and the consumption estimates presented in the criteria document results in a calculated lifetime cancer risk of approximately 1 in 100,000 from eating fish contaminated at the nominal detection level of 1 part per trillion (ppt). The FDA has advised that, for consumption patterns and fish species typical to the Great Lakes area, fish consumption should be limited if concentrations in the edible portion exceed 25 ppt, and should be banned if concentrations exceed 50 ppt. The CDC established a level of concern of 1 part per billion (ppb) in residential soils; this level of concern would vary depending on land use in an area. For example, levels as low as 6 ppt could be of concern in areas where dairy cattle are grazing, while levels well above 1 ppb could be acceptable in many industrial settings.

1.3 Findings and Conclusions

More than 4,000 samples from 862 sites nation-wide were collected and analyzed for the investigations of Tiers 3, 5, 6, and 7 (Figures 1-1, 1-2, 1-3, 1-4, and 1-5). Sampled media included soil, sediment, fish, water, and various animal and plant tissues. The major findings and conclusions from this study are:

Tiers 3 and 6

- The EPA estimates that approximately 10 percent of the facilities identified in its data bases as Tiers 3 and 6 sites would be found contaminated if they were sampled and analyzed using the protocols for this study.
- At contaminated Tier 3 and Tier 6 sites, the extent of contamination was usually limited to one or two soil samples with concentrations of 2,3,7,8-TCDD above 1 ppb. Only two Tier 3 sites were extensively contaminated; no Tier 6 sites were found extensively contaminated.
- Based on the limited number of sites found to be contaminated, the small number of positive samples at most of the contaminated sites, and the generally low levels of 2,3,7,8-TCDD detected, immediate national investigation of all of the remaining Tiers 3 and 6 facilities does not appear warranted.
- All contaminated Tier 3 sites were at or near facilities that handle 2,4,5-T, 2,4,5-TCP, and/or silvex, and the two extensively contaminated facilities both handled more than 100,000 pounds of these compounds. Therefore, the EPA is undertaking further evaluation of all other large handlers of these three compounds. The EPA sampled 12 of the 29 facilities handling greater than 100,000 pounds of these compounds during the study and is now collecting information on the 17 remaining facilities.
- All contaminated sites have been referred to the Superfund program for appropriate follow-up actions where necessary.

Tier 5

- Contamination was found in various media (soil, sediment, and fish) at 15 of the 26 sites sampled where 2,4,5-T, silvex, and 2,4,5-TCP-based pesticides were used.

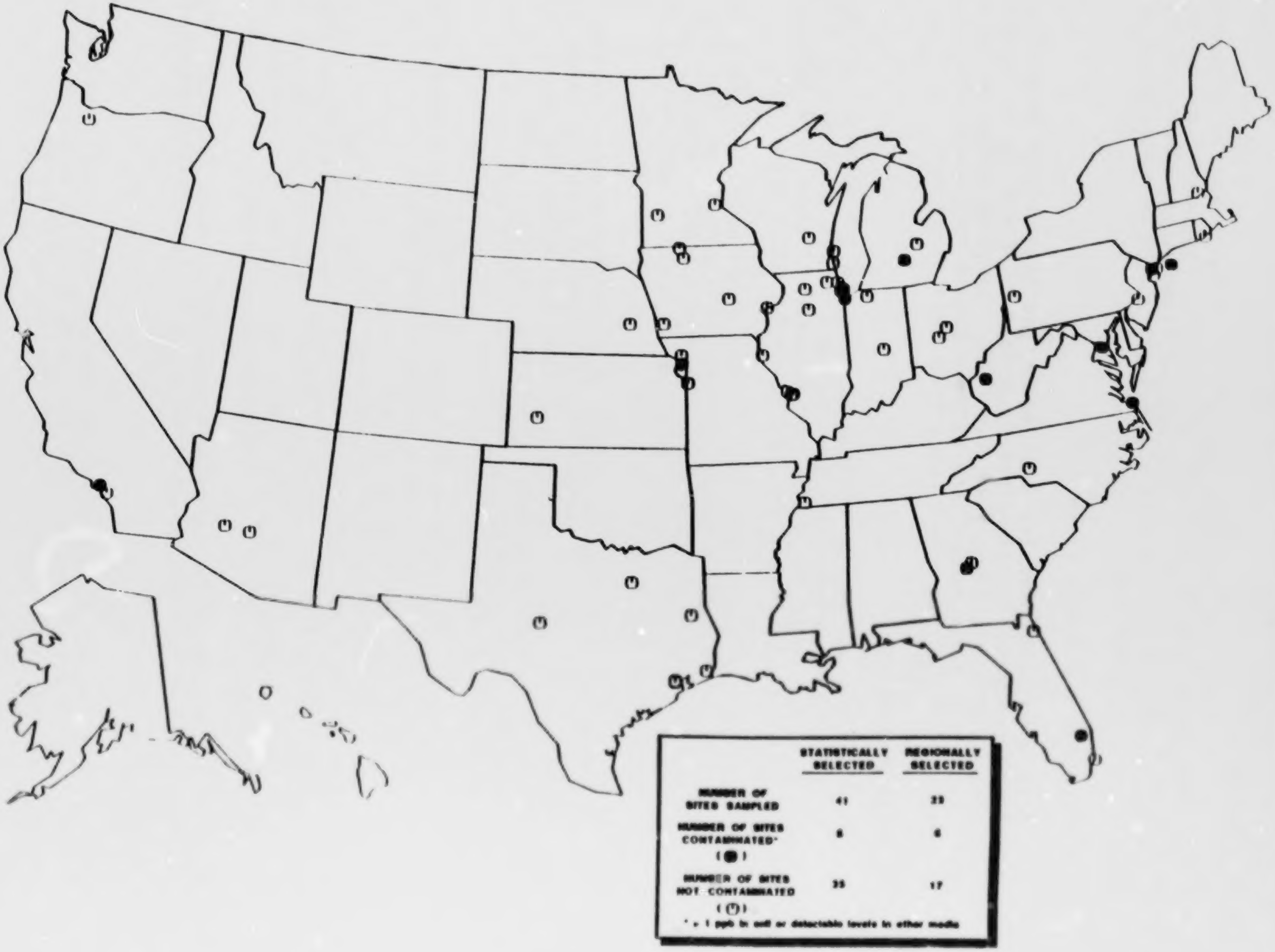

STATISTICALLY SELECTED
REGIONALLY SELECTED
NUMBER OF SITES SAMPLED
41
23
NUMBER OF SITES CONTAMINATED*
(●)
8
6
NUMBER OF SITES NOT CONTAMINATED
(◎)
33
17
* > 1 ppb in soil or detectable levels in other media

FIGURE 1-1. LOCATIONS OF SAMPLED TIER 3 SITES

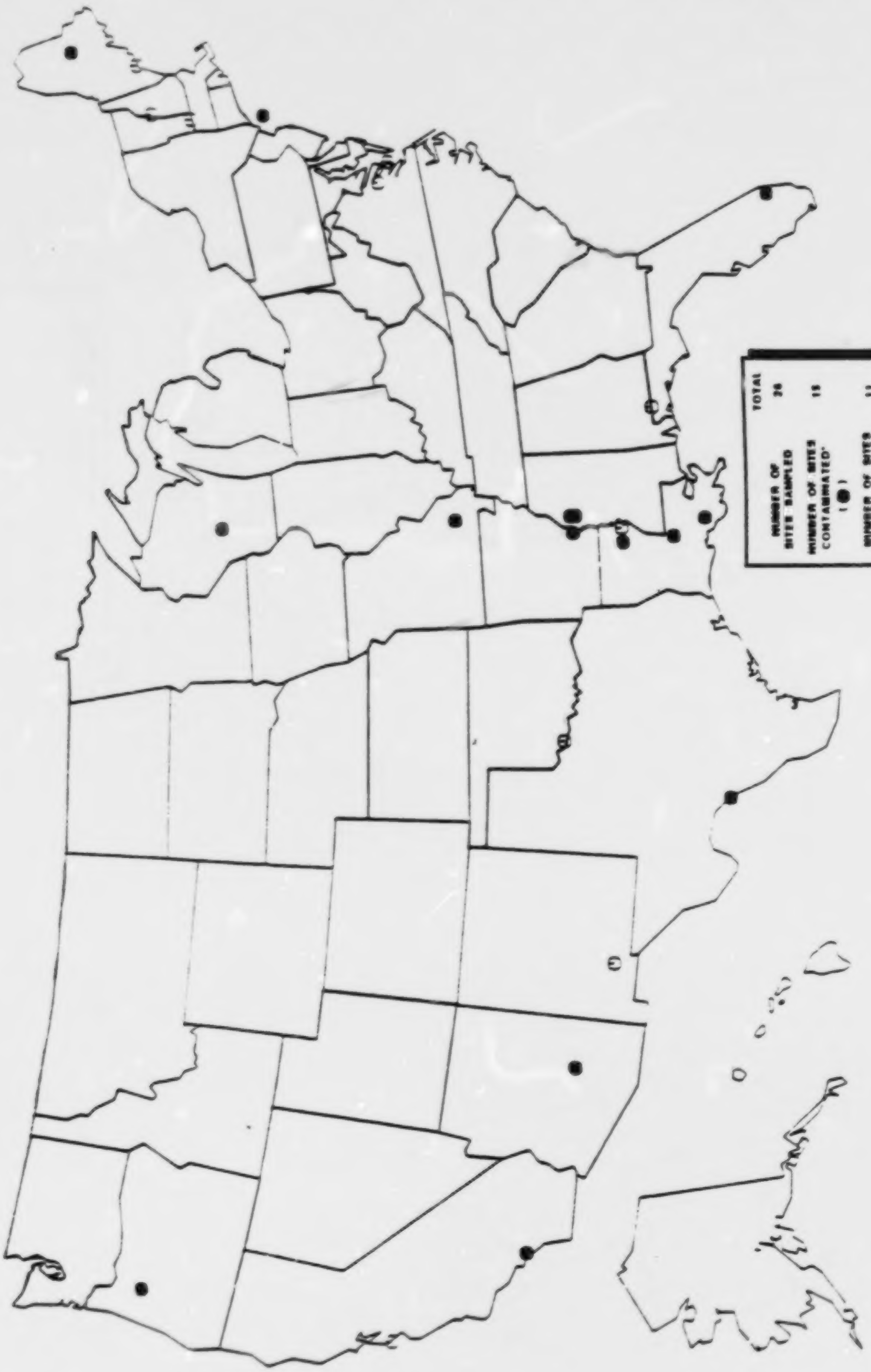

TOTAL
NUMBER OF SITES SAMPLED 26
NUMBER OF SITES CONTAMINATED* (●) 15
NUMBER OF SITES NOT CONTAMINATED (○) 11
* detectable levels (ppt)

FIGURE 1-2. LOCATIONS OF SAMPLED TIER 5 SITES

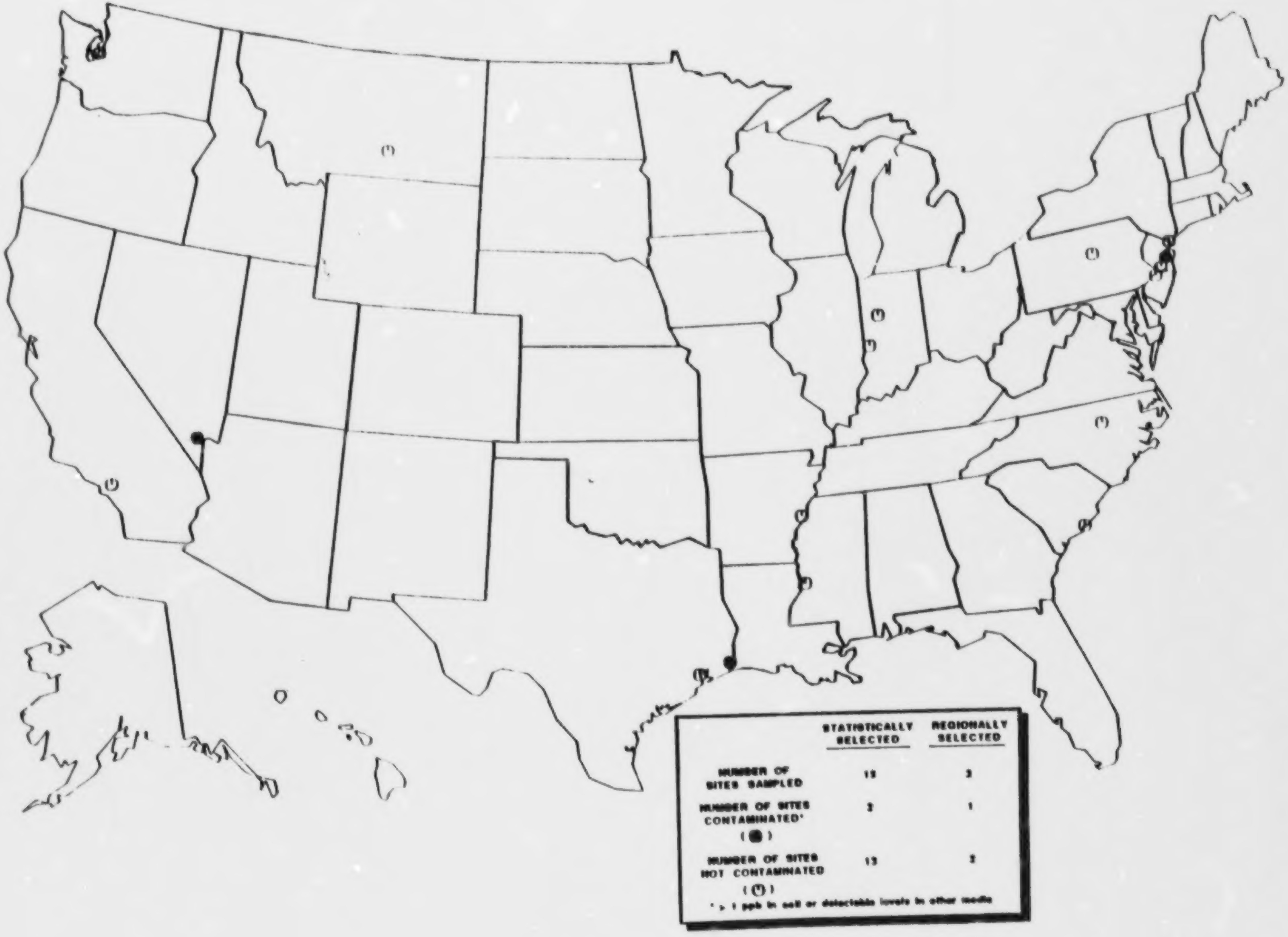

STATISTICALLY SELECTED
REGIONALLY SELECTED
NUMBER OF SITES SAMPLED
15
3
NUMBER OF SITES CONTAMINATED*
(●)
2
1
NUMBER OF SITES NOT CONTAMINATED
(○)
13
2
* > 1 ppb in soil or detectable levels in other media

FIGURE 1-3. LOCATIONS OF SAMPLED TIER 6 SITES

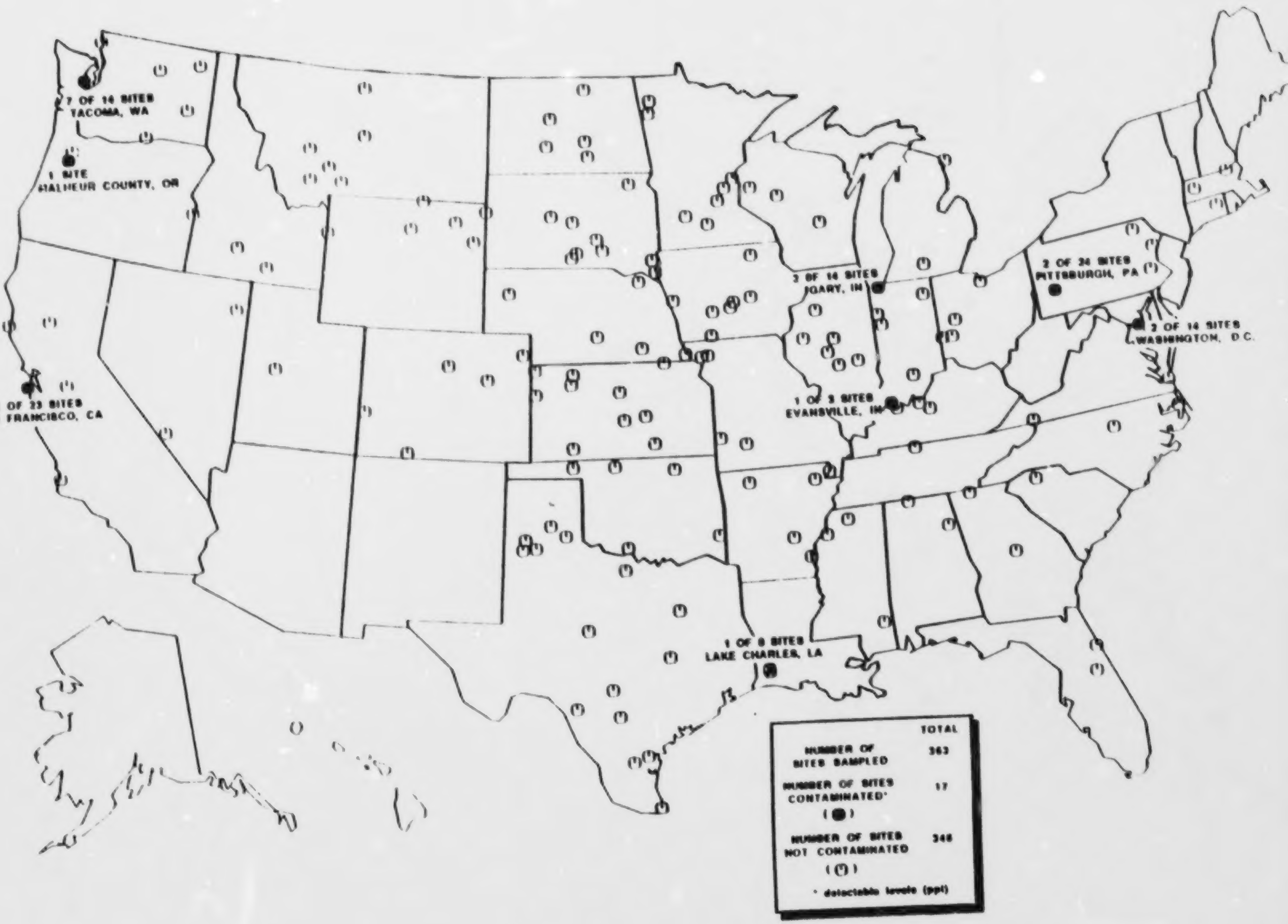

7 OF 14 SITES TACOMA, WA
1 SITE MALHEUR COUNTY, OR
1 OF 23 SITES SAN FRANCISCO, CA
2 OF 14 SITES GARY, IN
1 OF 3 SITES EVANSVILLE, IN
2 OF 24 SITES PITTSBURGH, PA
2 OF 14 SITES WASHINGTON, D.C.
1 OF 8 SITES LAKE CHARLES, LA
TOTAL
NUMBER OF SITES SAMPLED 363
NUMBER OF SITES CONTAMINATED* (●) 17
NUMBER OF SITES NOT CONTAMINATED (○) 346
* detectable levels (ppt)

FIGURE 1-4. LOCATIONS OF SAMPLED TIER 7 SOIL SITES

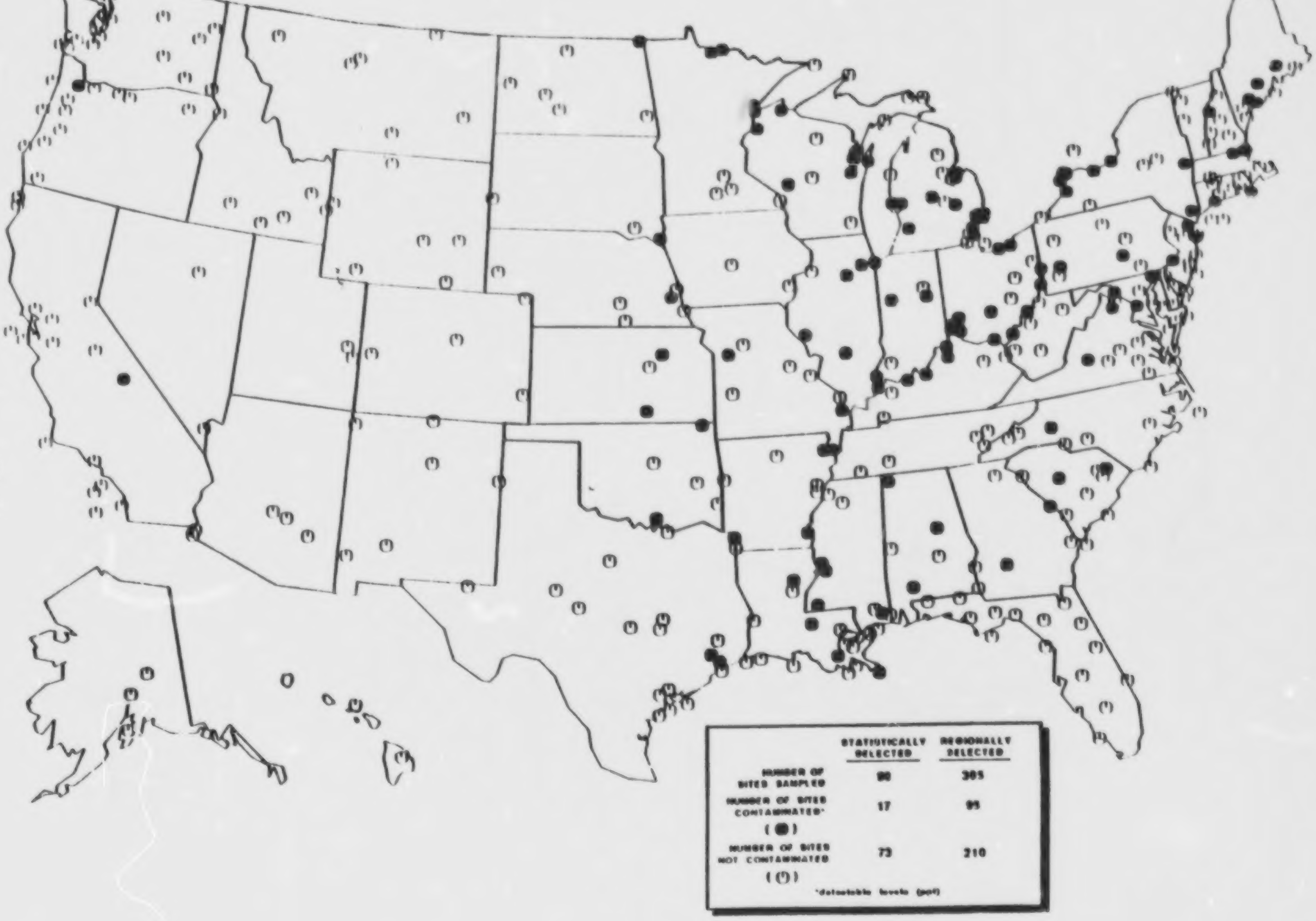

STATISTICALLY SELECTED
REGIONALLY SELECTED
NUMBER OF SITES SAMPLED
90
305
NUMBER OF SITES CONTAMINATED*
(●)
17
95
NUMBER OF SITES NOT CONTAMINATED
(○)
73
210
*detectable levels (ppt)

FIGURE 1-5. LOCATIONS OF SAMPLED TIER 7 FISH AND SHELLFISH SITES

- Contaminated sites included forests, rangeland, rice fields, sugarcane fields, canals adjacent to sugarcane fields, and rights-of-way. However, at sites where spraying of pesticides occurred, the levels found were generally very low (less than 5 ppt) and therefore not of concern. With the exception of certain pesticide mixing-loading areas, further national investigation of spray areas does not appear to be warranted.

- The highest levels for each medium were found where sampling was targeted for specific areas most likely to be contaminated (areas where contaminants would tend to accumulate).

- 2,3,7,8-TCDD was more frequently detected and was occasionally at higher levels at Tier 5 sites than at background sites (Tier 7). Soils collected at contaminated sites had 2,3,7,8-TCDD levels between 0.2 and 6623 ppt; levels in sediments were between 0.7 and 200 ppt; and levels in whole fish were between 9 and 47 ppt.

- The current source of 2,3,7,8-TCDD at the most significantly contaminated site (Petenwell Flowage) may not be related to slimicide use. (Certain pulp and paper mill processes are currently suspected of being the source of 2,3,7,8-TCDD in the Petenwell Flowage, and investigations of these sources are currently underway in coordination with other pulp and paper mill studies, as described in the Tier 7 discussion.)

Tier 7

- 2,3,7,8-TCDD was detected infrequently and at very low levels at the statistically selected background soil sites. Seventeen of the 221 urban sites and 1 of the 138 rural sites had detectable levels, with the highest level found being 11.2 ppt in an urban soil sample.

- 2,3,7,8-TCDD was detected more frequently in background fish samples than in background soil samples. The EPA estimates that 21 percent of the sites in the U.S. Geological Survey's national monitoring networks would have detectable levels of 2,3,7,8-TCDD in fish. The frequency of detection is greater (31 percent) at sites selected by the EPA's regional offices, many of which are near industrial and urban areas.

- An even higher proportion (23 of 29) of Great Lakes fish sampling sites was found to have detectable levels of 2,3,7,8-TCDD. This is consistent with previous findings and is not surprising since the long water retention times tend to increase bioaccumulation potential. Outside of the Great Lakes, fish contamination was primarily found in major river systems, such as the Ohio and Mississippi Rivers, or in waterways with significant industrial activity.

- Levels of 2,3,7,8-TCDD found in whole fish ranged up to 85 ppt, while levels found in filets ranged up to 41 ppt. Two fish consumption advisories have been issued based on findings from the study.

- Levels of 2,3,7,8-TCDD in fish filet samples may be a cause for concern at specific locations under certain consumption patterns; local exposure conditions need to be evaluated to determine a level of concern for those areas.

- Fish and shellfish from estuarine and coastal waters were rarely contaminated with 2,3,7,8-TCDD; three of the four contaminated sites were in areas heavily influenced by industrial discharges.

- A previously unsuspected possible source of 2,3,7,8-TCDD contamination in some areas appears to be certain types of pulp and paper mill discharges; mills using a chlorine-bleaching process are being investigated by the EPA, the states, and the paper industry to determine the source of contamination within the mills.

- Since recent studies indicate that 2,3,7,8-TCDD has a half-life of less than one year in fish, fish contamination is a current and continuing phenomenon.

1.4 Accomplishments

There were several significant accomplishments that resulted from the National Dioxin Study. These include:

- A major increase in the amount of available data and knowledge on 2,3,7,8-TCDD levels in the environment;

- Development of more reliable and less costly analytical methods to routinely measure 2,3,7,8-TCDD at the ppt level of detection, or lower in several types of environmental media;

- Development of a sampling guidance document to ensure uniform sampling procedures for this type of study; and

- Development of uniform review procedures to assess and validate analytical data.

2.0 INTRODUCTION

On December 15, 1983, the Environmental Protection Agency (EPA) issued its Dioxin Strategy (EPA, 1983a) for identifying, investigating, and cleaning up sites contaminated by dioxin, particularly 2,3,7,8-tetrachlorodibenzo-*p*-dioxin (2,3,7,8-TCDD). The major factors that led to the development of the Dioxin Strategy were:

(1) the toxicity of chlorinated dioxins, particularly 2,3,7,8-TCDD;

(2) the persistence of dioxins in soil and sediments;

(3) the detection of dioxins at a variety of sites in the U.S.; and

(4) the need for a systematic study to determine the extent of dioxin contamination.

Although there are 75 isomers of chlorinated dioxins, the strategy focused on the 2,3,7,8-TCDD isomer, primarily because it is thought to be the most toxic of the dioxins and is the one about which the most is known. Exceptionally low doses of 2,3,7,8-TCDD elicit a wide range of toxic responses in animals, including carcinogenicity, teratogenicity, fetotoxicity, reproductive dysfunction, and immunotoxicity. The EPA's Carcinogen Assessment Group has determined that there is sufficient evidence to conclude that 2,3,7,8-TCDD is an animal carcinogen and probably a carcinogen in humans as well. This compound is the most potent animal carcinogen evaluated by the EPA.

The EPA (1984a) has published a water quality criteria document, which presents estimates of the increased cancer risk from consuming contaminated water and fish from those waters. The document presents an estimated increased lifetime risk of 1 additional cancer in 1,000,000 people from drinking water and eating fish from waters contaminated at a concentration of 0.013 part per quadrillion (ppq). The EPA's assessment shows that the risk is primarily associated with the consumption of contaminated fish. The Food and Drug Administration (FDA, 1981) advised the State of Michigan that fish consumption should be limited if 2,3,7,8-TCDD levels in samples of the edible portions were above 25 parts per trillion (ppt), and should be banned if levels were above 50 ppt. This advisory is based on consumption patterns in the Great Lakes area. The edible portions of fish are generally the filets, although whether the filets should be analyzed with the skin on or off varies according to the size and type of fish. All filet analyses for the National Dioxin Study were done with the skin off.

The Centers for Disease Control (Kimbrough et al., 1984) has indicated that 2,3,7,8-TCDD levels above 1 part per billion (ppb) in residential soils are of concern, particularly to children living in contaminated areas. Levels of concern in industrial areas would be somewhat higher because of the reduced potential for ingestion of soil, particularly by children. On the other hand, levels of concern in grazing areas are lower because of the potential for 2,3,7,8-TCDD to bioaccumulate in grazing animals. The CDC guidelines indicate that soil concentrations of 6 ppt and 20 ppt can produce maximum allowable residues in milk and beef, respectively. (Additional discussions of these health assessments are presented in Appendix A.)

The 2,3,7,8-TCDD isomer appears to be persistent, although not particularly mobile, in the environment. It has a high potential for bioaccumulation, and is strongly adsorbed to soil or sediment (Appendix B).

Sampling and analysis of 2,3,7,8-TCDD in the environment have been limited, primarily because of the difficulties of analysis at the relatively low concentrations found in the environment. At the time the Dioxin Strategy was developed, numerous sites had been confirmed to be contaminated with 2,3,7,8-TCDD. The EPA, other federal agencies, and state and municipal agencies have all been involved in assessing these and other contaminated sites, and have initiated appropriate actions to protect public health.

The EPA developed the Dioxin Strategy to determine the overall extent of dioxin contamination and to provide a systematic approach for dealing with dioxin contamination problems. To implement the strategy, the EPA defined seven categories (or tiers) of sites for investigation, ranging from the most probable tier of contamination (Tier 1) to the least likely (Tier 7) as follows:

Tier 1 - 2,4,5-trichlorophenol (2,4,5-TCP) production sites and associated waste disposal sites;

Tier 2 - Sites and associated waste disposal sites where 2,4,5-TCP was used as a precursor to make pesticidal products;

Tier 3 - Sites and associated waste disposal sites where 2,4,5-TCP and its derivatives were formulated into pesticidal products;

Tier 4 - Combustion sources;

Tier 5 - Sites where 2,4,5-TCP and pesticides derived from 2,4,5-TCP have been, or are being, used on a commercial basis;

Tier 6 - Sites where improper quality control on manufacturing of certain organic chemicals and pesticides could have resulted in the inadvertent formation of 2,3,7,8-TCDD; and

Tier 7 - Control sites where contamination from 2,3,7,8-TCDD is not suspected.

A complete investigation at all sites in Tiers 1 and 2 is being conducted because they are suspected of being the most contaminated. Only a representative sample of sites in the other tiers was initially investigated because of 1) the large number of sites in each of those tiers, and 2) the lower potential for contamination at those sites. Investigations conducted at sites in Tiers 1 and 2 are being managed by the Office of Solid Waste and Emergency Response (OSWER) and are being funded under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA).

The investigations of sites in Tiers 3 through 7 constitute "The National Dioxin Study". The Office of Water (OW) was responsible for the studies in Tiers 3, 5, 6, and 7; this report describes the approach to and the results of those studies. The Office of Air and Radiation (OAR) managed the studies in Tier 4; those results are presented in a separate report.

Because of a lack of documentation on the identity or location of storage sites, such as the contaminated site at Fort A.P. Hill in Virginia where 2,3,7,8-TCDD was found in soil at concentrations of up to 1200 ppb, these sites were not incorporated into the overall investigation. Sites associated with the transportation and distribution of the chemicals of concern also were not investigated for the same reasons.

3.0 DESCRIPTION OF THE NATIONAL DIOXIN STUDY

3.1 Objective

The objective of the National Dioxin Study was to examine the extent of 2,3,7,8-TCDD contamination in each of the study tiers. Specifically, in Tiers 3 and 6 the objective was to determine the percentage of the facilities with 2,3,7,8-TCDD concentrations in soil above 1 part per billion (ppb), or at any detectable level in other environmental media (e.g., fish in nearby streams). The objective of the Tier 5 investigation was to determine whether 2,3,7,8-TCDD could be detected in selected areas where use of pesticides suspected of containing 2,3,7,8-TCDD as a contaminant has been documented. The objective of the Tier 7 study was to evaluate the extent and severity of 2,3,7,8-TCDD contamination in fish and soil samples from background sites at a level of detection of approximately 1 part per trillion (ppt). The National Dioxin Study objectives are discussed in detail in the "Quality Assurance Project Plan for Tiers 3, 5, 6, and 7 of the National Dioxin Study" (EPA, 1984b).

All sites found to contain 2,3,7,8-TCDD were referred to appropriate EPA offices or other federal or state agencies for appropriate response or follow-up action.

3.2 Approach

The EPA's Office of Water Regulations and Standards (OWRS) was responsible for developing the study design and work plan, and for the statistical selection of sites to be sampled. The regional offices assisted in the planning and site selection for the study, and were responsible for managing the sampling effort. Most of the actual sampling was done by state agency personnel and the EPA contractors. The analysis of samples was done by OSWER's Contract Laboratory Program (CLP), three EPA laboratories (Duluth, Bay St. Louis, and Research Triangle Park), and Wright State University.

The specific steps in the development and implementation of the National Dioxin Study were (Figure 3-1):

1. Development of the Quality Assurance Project Plan;
2. Site Selection;
3. Preparation of Site-specific Sampling Plans;
4. Sampling of Sites;
5. Analysis of Samples;
6. Data Review and Validation; and
7. Data Management.

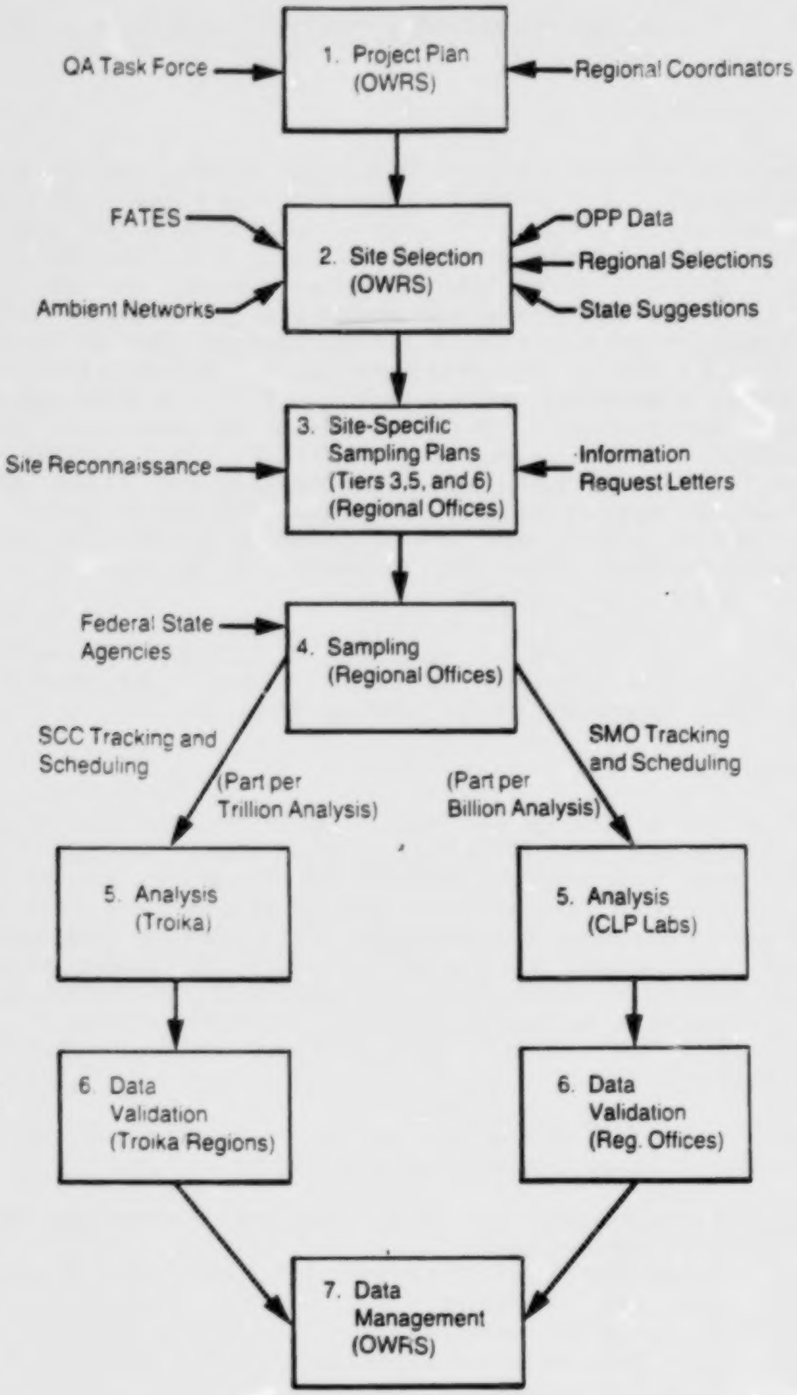

1. Project Plan (OWRS)
QA Task Force
Regional Coordinators
2. Site Selection (OWRS)
FATES
Ambient Networks
OPP Data
Regional Selections
State Suggestions
3. Site-Specific Sampling Plans (Tiers 3,5, and 6) (Regional Offices)
Site Reconnaissance
Information Request Letters
4. Sampling (Regional Offices)
Federal State Agencies
SCC Tracking and Scheduling
(Part per Trillion Analysis)
SMO Tracking and Scheduling
(Part per Billion Analysis)
5. Analysis (Troika)
5. Analysis (CLP Labs)
6. Data Validation (Troika Regions)
6. Data Validation (Reg. Offices)
7. Data Management (OWRS)

FIGURE 3-1 ACTIVITIES AND DATA FLOW IN THE NATIONAL DIOXIN STUDY

3.2.1 Development of the Quality Assurance Project Plan

The OWRS, with the assistance of the Quality Assurance Task Group (composed of headquarters and regional personnel) and the regional dioxin study coordinators, prepared a Quality Assurance Project Plan, as required by the EPA for all environmental monitoring tasks. The project plan provided an overview of the study and included study objectives, site selection methodology, field sampling procedures, sample custody procedures, references for analytical protocols, field and laboratory audit procedures, and data quality requirements and assessment procedures.

Before implementation of the study, the project plan underwent extensive internal (EPA) and external reviews. External reviewers included staffs of the Centers for Disease Control (CDC) and the Office of Technology Assessment, several members of the EPA's Science Advisory Board, and the American Chemical Society.

3.2.2 Site Selection

The EPA used several different approaches to identify potential sampling sites in the various tiers. The statistically selected Tier 3 sites were chosen from those facilities identified in the FIFRA and TSCA Enforcement System (FATES) data base as formulators or packagers of the Tier 3 pesticides. Statistically selected Tier 6 sites were chosen from facilities identified as producers of Tier 6 chemicals or pesticides in the Directory of Chemical Producers (SRI, 1977-1983), the EPA publication Dioxins (EPA, 1980), or the FATES data base. In addition, the regional offices and states selected sites of particular interest for sampling in these two tiers.

The regional offices sent information request letters to the facilities selected in Tiers 3 and 6 to verify existing EPA records on chemicals and volumes formulated or produced, and to obtain additional information on the types and quantities of waste generated, the waste disposal methods, and the location of disposal sites. In addition, regional staff visited the selected sites in Tiers 3 and 6 prior to sampling to identify potential sampling locations. In some cases the information gathered through these efforts resulted in a decision not to sample a particular facility, either because the facility did not actually produce or formulate the compounds of interest or because site reconnaissance revealed that the site was not suitable for sampling (e.g., extensive paving).

The sites in Tier 5 were selected based on pesticide use information provided by the Office of Pesticide Programs (OPP), the regional offices, and state and local agencies. In this tier, a statistical sample was not practical because of the variety of uses and conditions. As a result, a number of sites were purposely selected to provide a range of conditions and uses.

For Tier 7, sampling sites were statistically selected from three national environmental monitoring networks. Soil sampling locations were selected from the Urban and Rural Soil Networks of the EPA's National Soils Monitoring Program. Fish sampling locations were selected from the combined National Stream Quality Accounting Network (NASQAN) and the Benchmark Network, both established by the U.S. Geological Survey (USGS). In addition, the regional offices selected a large number of fish sampling locations. For purposes of this report, these sites are referred to as "background" sites.

3.2.3 Preparation of Site-specific Sampling Plans

Site-specific sampling plans were prepared by the regional offices for each site to be sampled in Tiers 3, 5, and 6. These plans included information on site location, site history, the location and rationale for each sample to be collected, and site-specific safety and community relations plans. The OWRS reviewed the sampling plans to ensure that they were consistent with the objectives of each tier. Plans were not required for Tier 7 sites, as the location and type of sample were determined by the site selection process.

3.2.4 Sampling of Sites

Field sample collection activities were managed by the regional offices and involved the participation of state and local agencies and EPA contractors as well. The OWRS, with the assistance of the regional coordinators, developed a guidance document, the "Sampling Guidance Manual for the National Dioxin Study" (EPA, 1984c) to provide uniform methods for collecting, preserving, shipping, and tracking environmental samples for the study. In cases where the guidance manual was not applicable, the site-specific methods to be used were evaluated by the OWRS to assure consistency with the objectives of the study.

The soil sampling protocol specified that all samples would consist of 4-inch deep cores that would then be thoroughly mixed prior to extraction and analysis. The selection of a 4-inch core was a judgment based on environmental fate information such as that presented in Appendix B.

The fish sampling protocol was defined to limit variability among sites. Target fish species were specified to reduce interspecies variations, and fish of similar ages were collected where possible.

3.2.5 Analysis of Samples

Two major laboratory programs performed analyses for the study: (1) the Contract Laboratory Program (CLP), consisting of commercial laboratories under EPA contract and managed by the Office of Solid Waste and Emergency Response; and (2) the Troika, consisting of three EPA laboratories (Duluth, Bay St. Louis, and Research Triangle Park) in the EPA's Offices of Research and Development (ORD) and Pesticides and Toxic Substances (OPTS). The Troika contracted with Wright State University for additional assistance in sample analysis. Analytical methods used by the CLP had a nominal detection limit of 1 part per billion (ppb) for soils (dry weight), while methods used by the Troika and Wright State University had a detection limit of approximately 1 part per trillion (ppt) for all media (soil/sediment - dry weight; biological tissue - wet weight) other than water and approximately 10 parts per quadrillion (ppq) for water. The limit of detection was established as a signal level 2.5 times the noise level for each sample. For the most part, the CLP analyzed soil samples from Tiers 3 and 6; the Troika and Wright State University analyzed soil samples from Tiers 5 and 7, and other environmental samples from all tiers.

The Troika's analytical methods for routine analysis of 2,3,7,8-TCDD at ppt and ppq levels in biological tissue, water, and soil samples are described in "Analytical Procedures and Quality Assurance Plan for the Analysis of 2,3,7,8-TCDD in Tiers 3-7 Samples of the U.S. Environmental Protection Agency's National Dioxin Study" (EPA, 1984d). This document has undergone internal (EPA) and external peer reviews. The analytical procedures for the CLP had been previously developed and reviewed, and are presented in the Information for Bid for Chemical Analytical Services for 2,3,7,8-TCDD (EPA, 1984e).

3.2.6 Data Review and Validation

All laboratory data were validated before they were considered final. The Troika reviewed and evaluated data internally utilizing procedures reviewed by the QA Task Force. The regional offices reviewed and evaluated the CLP data. Section 5.0 discusses the data validation procedures followed by the laboratories and regional offices.

3.2.7 Data Management

All validated sample data and quality control (QC) data from the Troika and CLP laboratories were entered into EPA data bases, from which the necessary information will be transferred into STORET, the EPA's water quality file.

4.0 IMPLEMENTATION AND RESULTS OF THE STUDY

4.1 Tier 3

4.1.1 Objective

Tier 3 consisted of facilities and associated waste disposal sites where 2,4,5-TCP and its derivatives (listed below) were formulated into pesticidal products. Generally, these products were herbicides, insecticides, fungicides, and germicides.

Products	Uses
2,4,5-trichlorophenol (2,4,5-TCP)	fungicide; bactericide
2,4,5-trichlorophenoxyacetic acid (2,4,5-T)	plant hormone; herbicide; defoliant
silvex	herbicide; plant growth regulator
erbon	herbicide
ronnel	insecticide
hexachlorophene	topical anti-infective (restricted); germicidal soaps, veterinary medicine
isobac 20	topical anti-infective (restricted); germicidal soaps; veterinary medicine

The objective of the Tier 3 sampling program was to determine the percentage of facilities identified in the FIFRA and TSCA Enforcement System (FATES) data base as Tier 3 facilities that are contaminated with 2,3,7,8-TCDD above 1 part per billion (ppb) in soil, or at any detectable level in other environmental media (e.g., fish in nearby streams). The detection limits for other media, and therefore the levels that determine whether contamination is present, vary slightly from site to site.

4.1.2 Methods

Site Selection

Initially, the EPA identified 258 facilities in the FATES data base as Tier 3 sites. Additional queries of the data base identified another 54 facilities. This data base lists the quantities of each Tier 3 chemical formulated at each facility during the period 1976-1981. An additional 325 potential Tier 3 facilities were identified from four other data sources as described in the QA Project Plan; however, these were not included in the sampling frame because documentation that they actually did formulate the compounds of concern was not available.

Sixty-one facilities were selected using a stratified, random sampling approach from the 312 facilities identified in FATES (Appendix C presents detailed selection procedures). Fifty facilities were selected from the 258 initially identified in FATES and an additional 11 were selected from the 54 facilities later identified in FATES. Large facilities (those handling at least 100,000 pounds total of active ingredients listed in Section 4.1.1) were selected as part of the 61 facilities.

The regional offices identified 23 additional facilities of particular interest for sampling, based on known activities at the facility or on previous contamination incidents. The results for these facilities will be reported separately in this report; they were not used in the statistical analysis for this tier.

Sampling Locations

The specific sampling locations within each Tier 3 facility were determined on a site-by-site basis. A targeted sampling approach was used when information was available to allow identification of areas most likely to be contaminated. Targeted areas where contamination was considered most probable included loading/unloading areas, storage areas, disposal areas, and storm water drainage areas.

A random sampling scheme (described in the QA Project Plan) was developed for sites where there was not enough information to identify areas most likely to be contaminated.

At several sites a combination of the two sampling approaches was used. Some samples were targeted in areas of suspected contamination, while the remainder were randomly distributed across the rest of the site. In some cases, the areas of suspected contamination were large, and random sampling was done within those areas.

4.1.3 Results

Site Characteristics

Of the 61 statistically selected sites, 13 were considered ineligible (Table 4-1) because further information revealed that no Tier 3 compounds were actually handled at the facility or that

TABLE 4-1

STATISTICALLY SELECTED TIER 3 SITES THAT WERE INELIGIBLE*

Site

Region I
  Nutmeg Chemical Co.
  New Haven, CT

Region II
  Duveen Soap Corp.
  Brooklyn, NY

  Nationwide Chemical Co.
  Brooklyn, NY

Region IV
  Amrep, Inc. (formerly Aero Mist, Inc.)
  Marietta, GA

  Davis Specialty Chemicals, Inc.
  Ridgeland, MS

Region V
  Mogul Corp.
  Minneapolis, MN

  Roberts Consolidated Industries, Inc.
  Kalamazoo, MI

Region VII
  Mozel Chemical Products Co.
  St. Louis, MO

  Ross Daniels, Inc.
  W. Des Moines, IA

Region IX
  Kem Manufacturing Co.
  South San Francisco, CA

  Magna Corp.
  Ventura, CA

  Target Chemical Co.
  Cerritos, CA

Region X
  Reichhold Chemicals, Inc.
  Tacoma, WA

* Did not handle Tier 3 compounds or site was only a warehouse.

the site was only a warehouse. Seven other sites (Table 4-2) were not sampled because they were either covered with pavement or the soil on site had been so extensively reworked that no original soil could be identified for sampling. These seven sites are considered missing for purposes of statistical analysis, as they are still in the sample frame but could not be sampled.

Of the 41 eligible sampled facilities, 30 handled only one of the Tier 3 compounds, six handled two of the compounds, and five handled three of the compounds. Ronnel was the most widely handled pesticide (18 facilities), while 2,4,5-T and silvex were handled at 11 and 10 facilities, respectively.

Twenty-three regionally selected Tier 3 sites were sampled. Of these, 17 facilities handled only one of the Tier 3 compounds, four facilities handled two, one facility handled three, and one facility handled four of the compounds. Silvex, 2,4,5-T, and ronnel were the most widely handled compounds at these facilities.

Information about the generation and disposal of waste by Tier 3 facilities is often incomplete. Partial information for 33 of the 41 eligible statistically selected sampled sites indicated that 12 generated process wastewater and 17 generated solid waste (eight generated both). Information for 19 of the 23 regionally selected sampled sites indicated that 11 generated process wastewater and 16 generated solid waste (9 generated both). For several sites, however, it is not clear whether the liquid and solid wastes were related to the processing of the Tier 3 compounds.

None of the statistically selected sites and only two of the regionally selected sites that generated wastewater were direct dischargers to surface waters. Fifty percent of the Tier 3 sites that generated wastewater discharged to publicly owned treatment works, while the rest incinerated, evaporated, or deep well-injected their wastewater. Most of the solid wastes were disposed of in off-site landfills.

Analytical Results and Discussion

Data for the 41 statistically selected eligible sampled sites indicated contamination (soil concentrations at levels greater than or equal to 1 ppb or detectable levels in other media) at six of these sites (Table D-1, Appendix D). Five additional sites had 2,3,7,8-TCDD concentrations in soil below 1 ppb (Figure 4-1).

The estimate of facilities identified in the FATES data base that are actually eligible Tier 3 sites is 79 ± 10 percent (estimate ± 2 x standard deviation)(Appendix C). The estimate

TABLE 4-2

STATISTICALLY SELECTED TIER 3 SITES THAT COULD NOT BE SAMPLED*

Site

Region I
  Shield Packaging Co., Inc.
  Canton, MA

Region III
  Purex Corp.
  Philadelphia, PA

Region IV
  Tobacco States Chemical Co., Inc.
  Lexington, KY

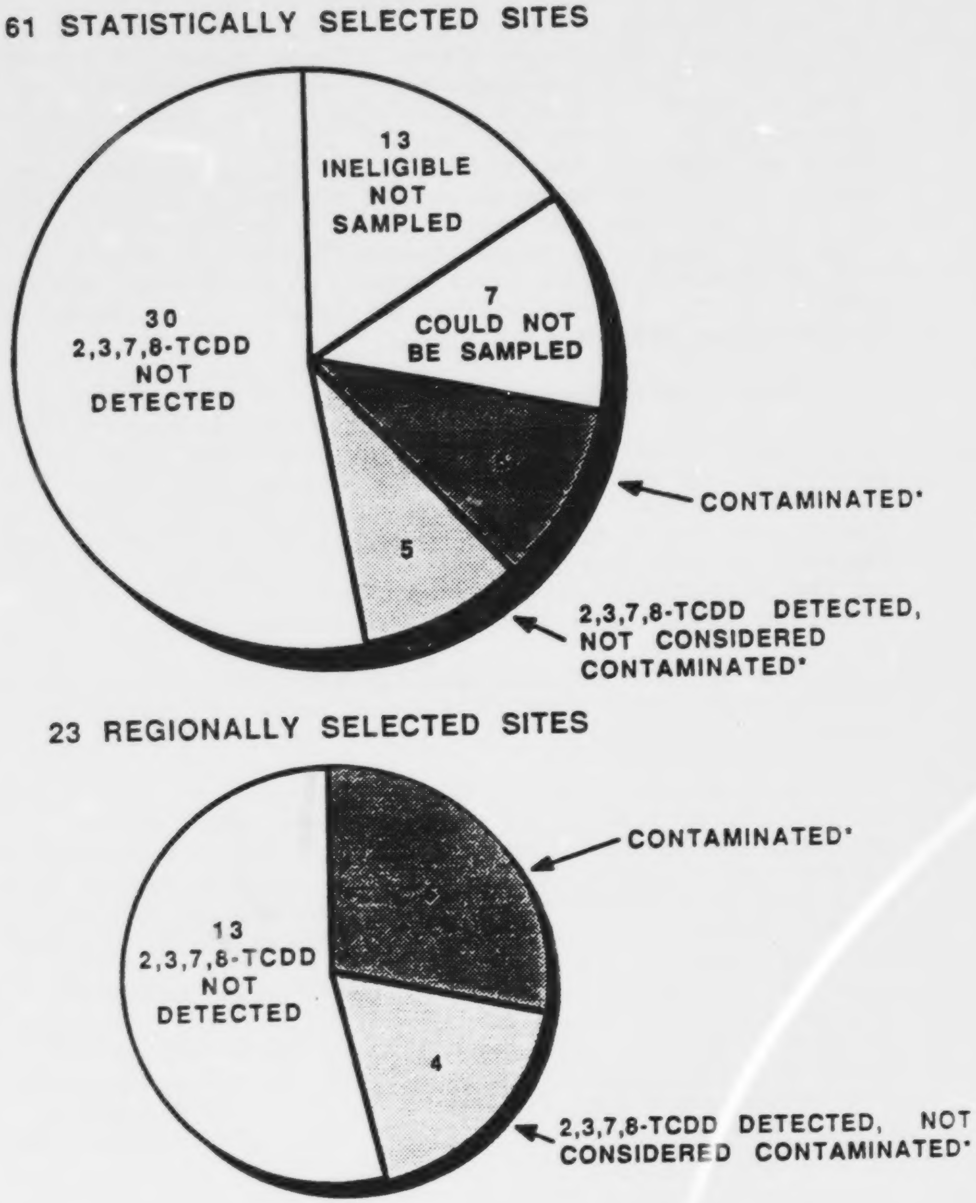
Region VI
  Amrep, Inc. (formerly Research Products Co.)
  Dallas, TX

Region X
  Associated Chemists
  Portland, OR

  Webfoot Fertilizer Company, Inc.
  Portland, OR

  Western Stockmen's Supply
  Twin Falls, ID

* Because of pavement or earth work on site.



*A SITE WAS CONSIDERED CONTAMINATED IF ANY SOIL SAMPLE CONTAINED MORE THAN 1 ppb OF 2,3,7,8-TCDD OR IF ANY SAMPLE FROM ANOTHER MEDIUM (FISH OR SEDIMENTS FROM ADJACENT STREAM,GROUNDWATER) CONTAINED A DETECTABLE LEVEL OF 2,3,7,8-TCDD. DETECTION LIMITS FOR OTHER MEDIA WERE APROXIMATELY 1 ppt EXCEPT FOR WATER FOR WHICH THE DETECTION LIMIT WAS APPROXIMATELY 10 ppq.

FIGURE 4-1. DISTRIBUTION OF CONTAMINATION AT TIER 3 SITES

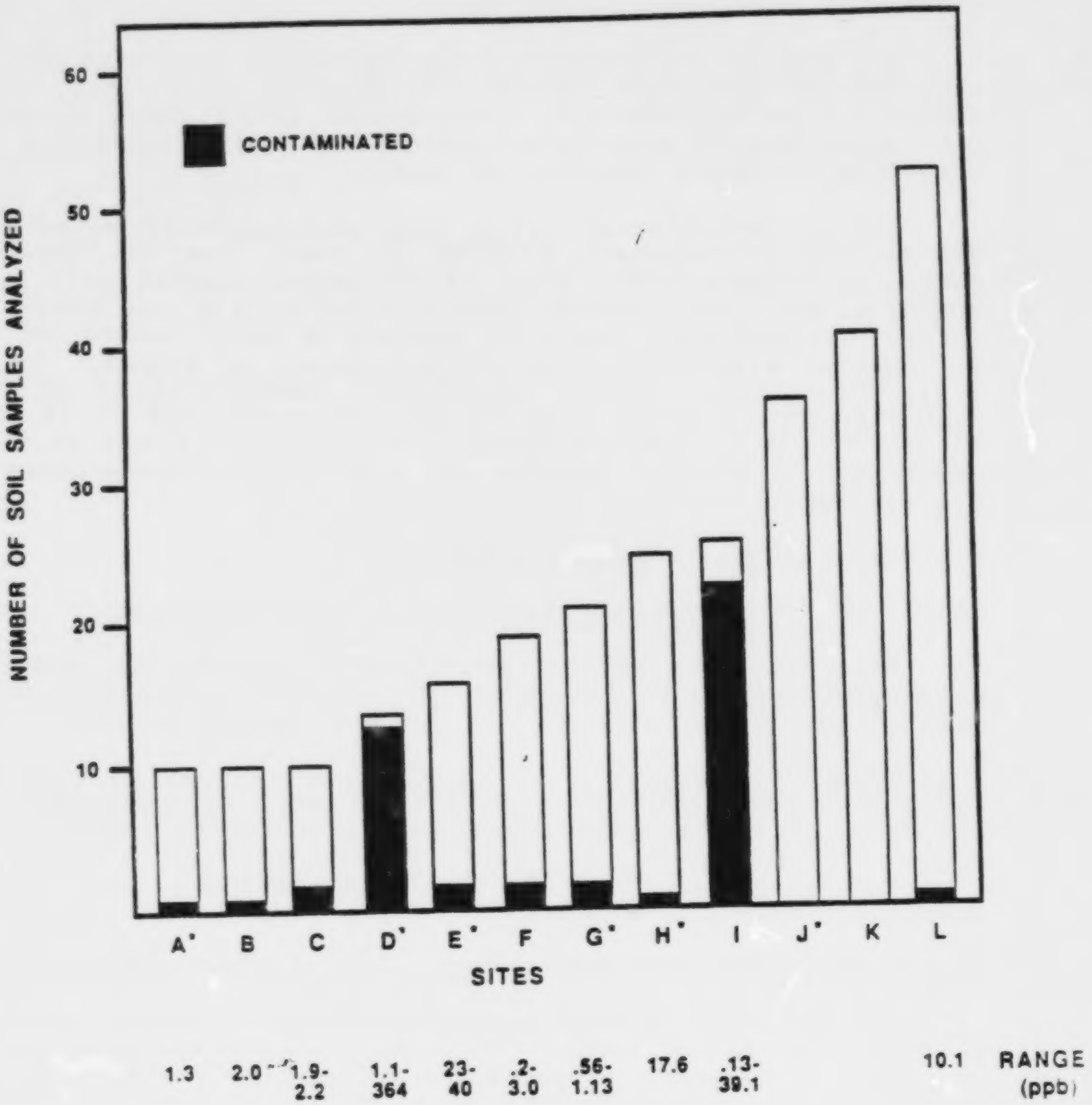
of eligible facilities that would be found contaminated if sampled depends on what assumption is made concerning the seven missing (not sampled) eligible sites. Three possible assumptions are: 1) the seven missing eligible sites are similar in frequency of contamination to those with data, 2) the seven sites are not contaminated, or 3) all seven sites are contaminated. If the first assumption for the missing sites is used, the estimate of eligible facilities that would be found contaminated is 16 ± 10 percent, and the estimate of all facilities in the FATES data base that would be found contaminated is 12 ± 8 percent. If the second assumption is used, the respective percentages are 13 ± 8 and 10 ± 6; if the third assumption is used, the respective percentages are 28 ± 10 and 22 ± 10.

These estimates apply to the 312 facilities identified in FATES, but do not necessarily apply to the additional 325 facilities identified from other sources but not listed in FATES. Possible explanations for why these facilities are not in the FATES data base include: 1) some of the facilities may have registered to handle the pesticides but never actually did so because of the cancellation proceedings for 2,4,5-T, and 2) some of the facilities may have handled only the pesticides of interest prior to 1976, before FATES was available.

Six of the 23 regionally selected sites were found to be contaminated, and four additional ones had detectable 2,3,7,8-TCDD levels in soil below 1 ppb (Table D-2, Appendix D).

Contamination when found was usually limited within a site area (Figure 4-2). At four of the six statistically selected contaminated sites, only one or two soil samples (4 to 13 percent of samples analyzed) had levels above 1 ppb. A fifth site had no soil contamination, but had levels of less than 3 ppt in all three fish samples from the adjacent river. The sixth site was widely contaminated and is discussed below. Similarly, four of the six contaminated regionally selected sites had only one or two soil samples (2 to 20 percent of samples analyzed) at levels above 1 ppb, and a fifth site had no soil contamination but had levels between 1 and 6 ppt in seven of eight fish samples and between 5.5 and 23 ppt in five of nine sediment samples from the adjacent river. The sixth site was widely contaminated and is discussed below.

The one widely contaminated statistically selected site (13 of 14 soil samples at levels greater than or equal to 1.0 ppb) handled 2,4,5-T, silvex, and 2,4,5-TCP, with the total amount handled greater than 100,000 pounds. This site was already under investigation through the Superfund program when it was selected for this study. The one widely contaminated regionally selected site (16 of 26 soil samples at levels greater than or equal to



* STATISTICALLY SELECTED SITES

NOTE: SITES J, K - CONTAMINATION IN MEDIA OTHER THAN SOIL

FIGURE 4-2. DISTRIBUTION OF SOIL SAMPLES AT CONTAMINATED TIER 3 SITES

1.0 ppb) also handled 2,4,5-T and silvex, with the total amount handled greater than 100,000 pounds.

The EPA has identified 29 facilities in the FATES data base that handled more than 100,000 pounds total of 2,4,5-T, silvex, and/or 2,4,5-TCP. The EPA investigated 12 of these as part of this study and is gathering information on the remaining 17 to determine if future sampling is needed.

All 12 contaminated sites (six statistically selected and six regionally selected) handled at least one of these three compounds (Figure 4-3). Nine of the sites handled only 2,4,5-T and/or silvex, two handled only 2,4,5-TCP, and one handled all three. In addition, one also handled a small amount of erbon and another also handled an unknown amount of ronnel. Overall, 2,4,5-TCP, silvex, and/or 2,4,5-T were handled at 23 of the 41 statistically selected eligible sampled sites and at 15 of the 23 regionally selected sampled sites. None of the facilities handling only hexachlorophene or ronnel were contaminated with 2,3,7,8-TCDD.

Discussion of Contaminated Sites

Region II: *Farmingdale Garden Lab - Farmingdale, NY

This facility, located on 0.5 acre, blended and repackaged silvex from 1965 to 1978 and erbon in 1969. More than 90 percent of the site is covered by a building and pavement.

Twenty-five random soil samples were collected from a 10- by 75-ft gravel area at the rear of the processing building. One of these samples contained 2,3,7,8-TCDD at 17.6 ppb.

This site has been referred to Superfund and will be resampled under that program.

Region II: *Rockland Chemical Co., Inc. - West Caldwell, NJ

This facility, located on approximately 1.8 acres, formulated products containing silvex from 1961 to 1979 and products containing 2,4,5-T until 1976. There are currently five underground storage tanks on-site which are used for storing solvents. A septic tank was used for disposal of process waste and sanitary wastewater before the plant connected to a treatment facility.

Ten soil samples were collected along the perimeter of former and current loading docks where runoff from on-site loading and

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"*" denotes a statistically selected site.

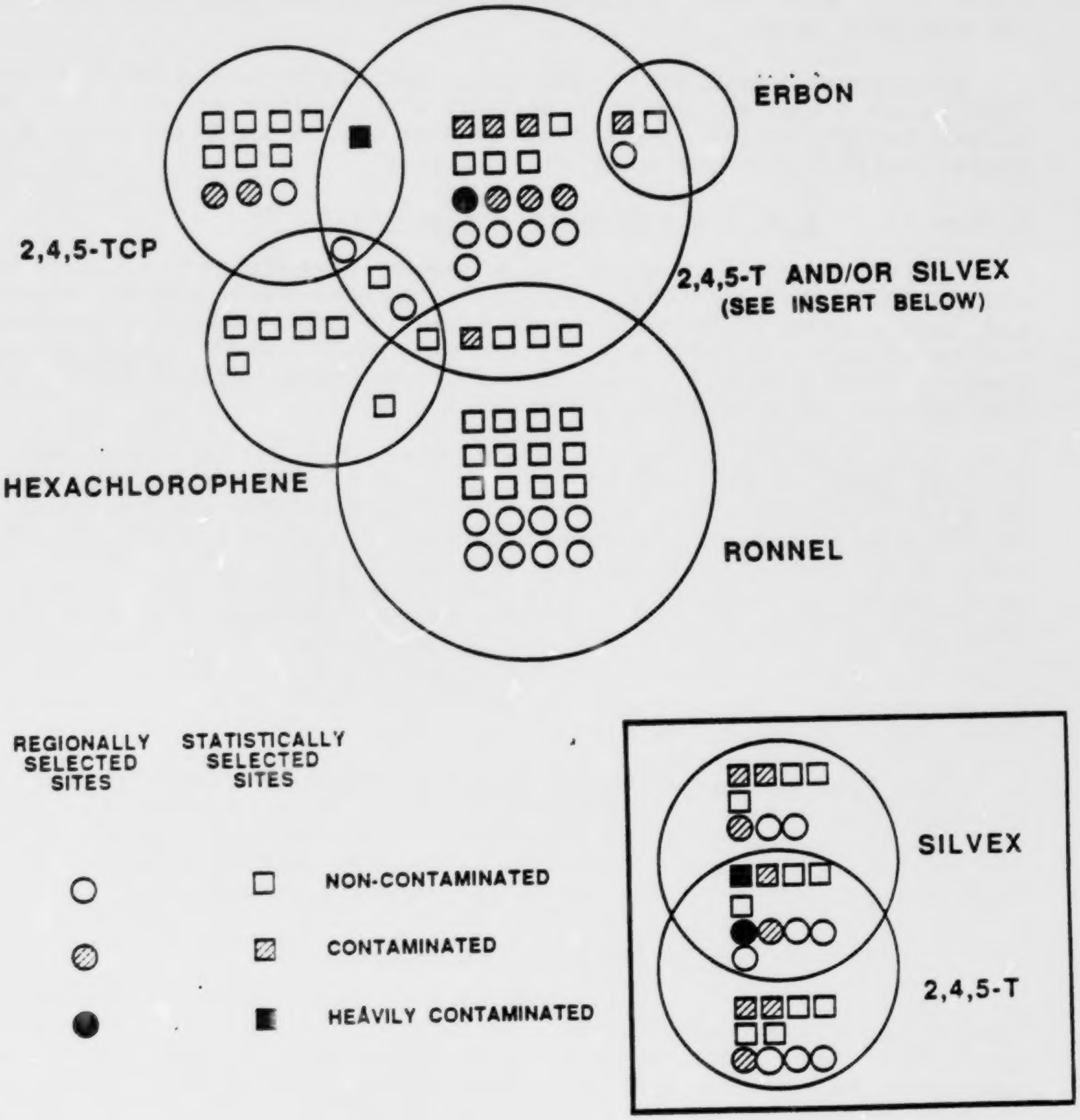
ERBON
2,4,5-TCP
2,4,5-T AND/OR SILVEX
(SEE INSERT BELOW)
HEXACHLOROPHENE
RONNEL
REGIONALLY SELECTED SITES
STATISTICALLY SELECTED SITES
NON-CONTAMINATED
CONTAMINATED
HEAVILY CONTAMINATED
SILVEX
2,4,5-T

FIGURE 4-3. DISTRIBUTION OF SAMPLED TIER 3 SITES BY CHEMICAL HANDLED

storage areas would collect. The one sample containing 2,3,7,8-TCDD (1.32 ppb) was collected down-gradient from the current loading dock area.

Additional sampling at the site indicated levels of 2,3,7,8-TCDD below 1 ppb at several storage and loading areas. The New Jersey Department of Environmental Protection is discussing possible remedial actions with the facility.

Region III: R.H. Bogle Company - Alexandria, VA

This facility, located on 5 acres, distributed 2,4,5-T and silvex from 1954 to 1979. These herbicides were stored on-site and loaded onto railroad sprayer cars for application to railroad rights-of-way. In 1978 most of the site was clay-capped to contain arsenic contamination. Residential townhouses, office buildings, and asphalt parking lots now cover the site.

As the site has been changed substantially in recent years, 40 soil samples were collected at 17 locations receiving runoff from the site prior to capping. No 2,3,7,8-TCDD was detected in any of these samples. However, five of the nine sediment samples taken from Oronoco Bay and the Potomac Estuary, which border the site, contained 2,3,7,8-TCDD at levels of 5.5 to 23 ppt. Seven of the eight fish collected from the Potomac Estuary within 2 miles of the site contained 2,3,7,8-TCDD at levels of 1.6 to 6.3 ppt. Since the samples containing 2,3,7,8-TCDD were collected off the site, there is no conclusive evidence that the contamination came from the Bogle facility.

The Centers for Disease Control concluded that no further sediment and fish sampling for 2,3,7,8-TCDD is required since the fish levels were well below the FDA action levels. The EPA Region III is evaluating the impact that dredging may have on the bioavailability of 2,3,7,8-TCDD in the Potomac Estuary.

Region III: *Holder Chemical Company - Ona, WV

This facility, located on 2.5 acres, used a number of insecticides and herbicides, including 2,4,5-T in formulating products. The years when 2,4,5-T was used in formulation are unknown. Based on a 1982 site evaluation, approximately 280 tons of contaminated topsoil containing malathion, chlordane, sevin, DDT, dieldrin, heptachlor, lindane, kepone, and 2,4-D were removed from the site (no dioxin analyses were performed).

"*" denotes a statistically selected site.

Thirty-six soil samples were collected, 31 from locations surrounding the main building and five from the wooded area bordering the site. No 2,3,7,8-TCDD was detected in any of these samples, nor in the five sediment samples and a clam sample collected from the nearby Mud River. However, all three fish samples collected from this river 0.5 mile downstream from the site contained 2,3,7,8-TCDD at levels between 0.5 to 2.9 ppt. There is no conclusive evidence that the contamination came from the Holder facility.

No follow-up action is planned for this site.

Region III: Smith Douglas (Borden) - Norfolk, VA

This facility, located on 35 acres, formulated products using silvex. The formulation activity took place in two buildings.

Fifty-three soil samples were collected: 15 from around the storage building, 14 from around the formulation building, 5 from ditches at the perimeter of the property, and 19 at various other locations around the site. Ten dust samples were also collected from the storage building and from the formulation building. A sample of trash from the formulation area was also analyzed. Only one soil sample contained 2,3,7,8-TCDD (10.1 ppb); it was collected along a driveway leading to the building where silvex was formulated. No 2,3,7,8-TCDD was detected in the dust or trash samples.

Intensive follow-up sampling under the Superfund Program was conducted around the formulation building. The location of 2,3,7,8-TCDD contamination was confirmed, with no additional contaminated locations being identified. The company has agreed to excavate the contaminated soil and dispose of it, along with the formulation equipment, in a manner acceptable to the EPA.

Region IV: Chem Spray - Belle Glade, FL

This facility, located on 2 acres, formulated products using large amounts (greater than 100,000 pounds) of 2,4,5-T from 1967 to 1977. A residue pile is located adjacent to a formulation building. In addition, canals border two sides of the site.

Nineteen soil samples were collected: two from the residue pile, four from outside the formulation building, two from between the formulation building and a second building, and three from around this second building. Eight random samples were also taken between the two buildings. The two soil samples containing 2,3,7,8-TCDD (0.2 and 3.0 ppb) were both collected outside the second building. Seven sediment samples were also collected from the canals. All contained 2,3,7,8-TCDD at levels between 20.9 to 515 ppt.

Additional sampling and analysis confirmed the isolated nature of the 2,3,7,8-TCDD contamination. The facility has secured the contaminated area. The EPA is currently pursuing alternatives for disposal.

Region IV: *Security Chem (Woolfolk Chem) - Fort Valley, GA

This facility, located on 22 acres, repackaged and stored silvex from 1978 to 1979 in a general warehouse which housed a loading dock.

Seventeen soil samples were collected: three from around and underneath the warehouse (the building is on raised blocks), three along the street where silvex was transported, five around another site building, five from various other site locations, and one from a drainage ditch. The soil sample containing 2,3,7,8-TCDD (23 ppb) was collected from underneath the warehouse where 55-gallon drums were stored. A field duplicate for the same sample contained 40 ppb. It appears that the contamination was due to spillage. The drainage ditch sample also contained 2,3,7,8-TCDD at 36.7 ppt.

Security Chem, as the responsible party, and the Georgia Environmental Protection Division conducted a comprehensive sampling survey of the entire facility, confirming the isolated nature of the contamination. Appropriate measures have been taken to secure these areas. The EPA is currently pursuing alternatives for disposal.

Region V: *ETM Enterprises (Parsons Chemical Works, Inc.) - Grand Ledge, MI

This facility, located on approximately 5 acres, formulated products using 2,4,5-T and ronnel for an unknown number of years, although the mixing, manufacturing, and packaging of agricultural chemicals in general took place there from 1945-1979. Several areas of this site had previously been found contaminated with other pollutants, and some excavation of contaminated soil has taken place.

Twenty-one soil samples were collected: seven from a stormwater drainage ditch, two from an area where a septic system was removed as a result of previous sampling, two at the storm drain pipe (one at the inlet and one at the open catch basin), four off the southwest corner of the building where previous sampling indicated other pollutant contamination (no previous 2,3,7,8-TCDD analyses), one from just outside the parking lot, four from along

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"*" denotes a statistically selected site.

the south side of the building near the loading dock in a low area (under downspouts), and one near the mid-north side of the building along the roof drain line. The two samples containing 2,3,7,8-TCDD (0.56 and 1.13 ppb) were collected at two depths at the location where storm water from the storm drain pipe discharges into the drainage ditch.

Additional samples, collected and analyzed at lower levels of detection, contained 2,3,7,8-TCDD in sediments from a nearby stream and the Grand River at levels of 9 and 15 ppt; soils on-site had levels between 0.005 and 0.246 ppb. The State of Michigan has fenced, covered, and paved the drain outlet. A septic tank and surrounding soils have been removed. Plant floor drains have been closed. Additional remedial measures are being discussed between the company and the State.

Region V: Nalco Chemical Company - Bedford Park, IL

This facility, located on approximately 21 acres, used large amounts of sodium 2,4,5-trichlorophenate (approximately 100,000 pounds) and 2,4,5-TCP (approximately 8,500,000 pounds). According to one of Nalco's suppliers, the concentration of 2,3,7,8-TCDD in the 2,4,5-TCP was less than 0.098 ppm. Formulation wastes were disposed of off-site with other solid waste from the plant, or with plant wastewater that went to the sanitary sewers after treatment (removal of oils and solids). The sludge was temporarily stored on-site and then disposed of off-site in a landfill. Products not meeting specifications were stored on-site in 55-gallon drums and then disposed of off-site in a landfill.

This site is extensively paved. Ten soil samples were initially collected: seven from loading docks, and one sample each from outside a warehouse, a processing building, and a storage building. These three samples were in areas of expected roof drainage. The two samples containing 2,3,7,8-TCDD (1.9 and 2.2 ppb) were collected at two of the loading docks, one at the drum-rinsing operation location and the other at a processing location. Significant levels of other dioxin isomers were also found in one of these samples.

Additional sampling at the site in areas adjacent to identified contamination and in areas of expected drainage indicated the presence of 2,3,7,8-TCDD ranging from 0.24 to 5.2 ppb in all samples; significant levels of other dioxin and furan isomers were also found. Contaminated areas have been covered with plastic and gravel. EPA issued an unilateral 106 order to Nalco to investigate the extent of contamination during a remedial investigation and to take appropriate steps to prevent migration.

Region V: *Riverdale Chemical Company - Chicago Heights, IL

This site formulated products using silvex, 2,4,5-T, and 2,4,5-TCP and was already scheduled for investigation under the Superfund Program prior to its statistical selection for this study. The sampling approach used to sample the site under Superfund was slightly different from those used at the other Tier 3 sites.

Fifteen soils samples were initially collected by gridding and sampling all the open areas. Areas covered by gravel or pallets were not sampled. Widespread 2,3,7,8-TCDD contamination was found on site; 13 of 14 soil samples collected contained 2,3,7,8-TCDD at concentrations ranging from 1.1 to 364 ppb.

Two Consent Orders are being implemented by the Riverdale Chemical Company. The first involves covering the area where 2,3,7,8-TCDD was detected with tarp or gravel. The second involves Riverdale's conducting a remedial investigation/feasibility study of the site and its surrounding areas to determine the extent of contamination. This information will be used to develop additional appropriate remedial action.

Region VII: Union Carbide Agricultural Products Company Inc.
(formerly Amchem Product Co.) - Saint Joseph, MO

This facility was owned by the Amchem Product Co. when it formulated products containing 2,4,5-T and silvex. More than 100,000 pounds of these compounds were used in formulation from about 1957 until about 1978. Union Carbide purchased the facility from Amchem Products in 1978. This site is about 7 acres, with about 5 acres of open fields.

Twenty-six soil samples were collected at this site: four from the railroad loading area, four from around a tank used to store 2,4,5-T, eight from a bare spot where a spill may have occurred, and ten from a drainage ditch that receives runoff from on-site loading and unloading areas. Valid analytical results were obtained for 25 of the 26 samples (questionable results were obtained from one of the drainage ditch samples). Of the 25 samples, detectable levels ranging from 0.13 to 39.1 ppb of 2,3,7,8-TCDD were found in 23; values greater than 1 ppb were detected in 16. The highest concentrations were observed in soils taken from the bare spot.

After being notified of the results from the sampling, Union Carbide voluntarily installed a fence around the entire

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"*" denotes a statistically selected site.

site in order to limit unauthorized access. The Superfund Program requested Union Carbide to evaluate pollution abatement options. Additional samples were collected by the EPA to determine the extent of pollution more accurately. Further negotiations concerning cleanup activities are on hold pending the review of analytical results from the additional sampling.

Region IX: Magna Corp. - Sante Fe Springs, CA

This facility, located on 2 acres, blended large amounts of 2,4,5-TCP (greater than 100,000 pounds) into products from 1961 to 1978.

Ten soil samples were collected along the perimeter of this facility where drainage would collect. The one sample containing 2,3,7,8-TCDD (2.0 ppb) was collected down-gradient from the 2,4,5-TCP mixing area.

The EPA issued an immediate removal order under Superfund. The company drummed all contaminated soil, sediment, and debris and conducted additional sampling in an off-site drainage ditch.

4.1.4 Findings

- The estimate of the percentage of Tier 3 facilities that are contaminated varies depending on the assumptions concerning the seven eligible sites that were not sampled. If these sites have a similar frequency of contamination as the sites with data, an estimated 12 percent of the Tier 3 facilities in FATES would be found contaminated.

- An estimate of the percentage of the additional 325 facilities identified from other sources that would be found contaminated cannot be determined.

- At contaminated sites, the extent of contamination was usually limited to one or two soil samples having concentrations of 2,3,7,8-TCDD above 1 ppb. Only two Tier 3 sites were extensively contaminated.

- All 12 contaminated sites were at or near facilities handling 2,4,5-TCP, 2,4,5-T, and/or silvex.

- The two extensively contaminated facilities were both large handlers of 2,4,5-T, 2,4,5-TCP, and/or silvex.

4.1.5 Conclusions

- Based on the limited number of sites found to be contaminated, the small number of positive samples at most of these sites, and the generally low levels of 2,3,7,8-TCDD detected, immediate national investigation of all of the remaining Tier 3 facilities does not appear to be warranted.

- Since the two extensively contaminated facilities were both large handlers of 2,4,5-T, 2,4,5-TCP, and/or silvex, further evaluation of other large handlers of these three compounds is warranted. The EPA sampled 12 of the 29 large handlers of these compounds as part of the study and is collecting information on the remaining 17 facilities.

4.2 Tier 5

4.2.1 Objective

Tier 5 sites consisted of areas where 2,4,5-TCP and pesticides derived from it (including 2,4,5-T and silvex) were used on a commercial basis. The objective of the Tier 5 sampling program was to determine whether 2,3,7,8-TCDD is present at detectable levels of approximately 1 ppt in areas where major uses of these pesticides occurred. The detection limits, and therefore the levels that determine whether contamination is present, vary slightly from site to site.

With one exception, Tier 5 sampling was limited to those areas where the use of 2,4,5-T or silvex has been documented, since information from the Office of Pesticide Programs (OPP, 1983b) indicated that these two compounds had been more heavily used in specific areas and had a greater potential for causing significant human exposure to 2,3,7,8-TCDD. The exception was an area where chlorophenol-based slimicides, reportedly containing 2,3,7,8-TCDD, were used by pulp and paper mills. The other compounds (including hexachlorophene, erbon, ronnel, and isobac 20) were of lesser interest because of: 1) low levels of the active ingredient pesticide in the end-products; 2) lack of use documentation; 3) use on very small areas; or 4) a wide diversity of uses at low levels of application.

4.2.2 Methods

Site Selection

To identify applicable sites, the Office of Pesticide Programs compiled general information on areas of use for the compounds of interest. The EPA regional offices, in conjunction with state or local agencies, then identified specific sites to be sampled. Twenty-six sites were selected for sampling in Tier 5. Selected sites included ones where present or past use of 2,4,5-TCP-based herbicides or slimicides had been documented, including rice fields, canals adjacent to sugarcane fields, rangelands, forests, rights-of-way, and recreational areas.

Sampling Locations

In most cases, suspected "hot spots" could not be identified within a pesticide use site, and the random sampling approach described for Tier 3 was used to select the sampling locations within a Tier 5 site. In a few cases, locations such as equipment loading areas or drainage ditches could be identified and were targeted for sampling, since 2,3,7,8-TCDD contamination, if present, was expected to be higher in these areas.

The environmental media to be sampled were determined by the regional offices on a site by site basis. They included soils, stream sediments, fish tissue, vegetation, and animal tissue. All analyses were done at detection levels of approximately 1 ppt, as soil concentrations below 1 ppb may be of concern in certain types of areas, such as grazing lands.

4.2.3 Results

Site Characteristics

A total of 26 Tier 5 sites were sampled, including six forest sites, seven rice fields, three sugarcane fields, three rights-of-way, three rangeland areas, and four aquatic sites (used for recreation, fisheries, or multiple uses) (Table 4-3). The herbicide 2,4,5-T had been applied at 18 of these sites, including three where silvex had also been applied. Silvex had been applied at five additional sites; chlorophenol-based slimicides had been used at one site; and documentation on use is being compiled for the two remaining sites.

Analytical Results and Discussion

2,3,7,8-TCDD was detected at 15 of the 26 sites (Table D-3, Appendix D), including two rights-of-way, one aquatic use site, two sugarcane fields, canals adjacent to one sugarcane field, four rice fields, three forest areas, one rangeland area, and one multiple use area. More than 40 percent of the soil and sediment samples taken at contaminated sites had 2,3,7,8-TCDD present above the detection limit of approximately 1 ppt. Two sites had detectable levels in fish. At one of these, all fish samples were contaminated. Soils initially collected at contaminated sites had levels of 2,3,7,8-TCDD between 0.6 and 564 ppt, with 67 percent below 5 ppt; levels in sediments were between 0.7 and 200 ppt, with 61 percent below 5 ppt; and levels in fish filets were between 8 and 23 ppt. No 2,3,7,8-TCDD was detected in animal tissue or vegetation samples collected from land used for grazing or raising crops; however, only a limited number of these samples were collected.

Discussion of Contaminated Sites

Region I: Grindstone, ME

In 1977, approximately 1,000 acres of railroad yards and railroad rights-of-way were sprayed with an herbicide containing 2,4,5-T. A 16-foot area, 8 feet to each side of the centerline of the tracks, received the herbicide directly and an estimated 2 feet beyond this area on each side received the herbicide from aerial drift. An 1,800-foot long section of this right-of-way was sampled.

TABLE 4-3
Tier 5 Site Characterization

Region	Name of Site	Site Use	Pesticide Applied	Date(s) Treated	Volume Applied	Area Applied	Rate of Application(AI)	Type of Application
I	Lake Abenaki, VT	Aquatic recreation and private water supply	Silvex	1975	5 gal. Silvex	15 acres (southern third)	1/3 gal/acre (calculated)	Spraying from boat
	Lake Clara, VT	Aquatic recreation	Silvex	1971-73 (once each year)	5 gal. (1973)	18 acres (1972)^2; spot treatment (1973)	Unknown	Spraying from boat
	Grindstone, ME	Railroad right-of-way	2,4,5-T^3	? - 1977	537.5 lbs.	1075 acres (along railroad)	0.5 lbs/acre	Spray
	Yarmouth, ME	Powerline Right-of-way	2,4,5-T	1978	unknown	Within 75 ft of tower centerline	Unknown	Sprayed at base of selected plant
II	Long Island Rail-Road, NY	Right-of-Way	2,4,5-TCP based herbicides	1970's	unknown	area unknown (along railroad)	unknown	spray
III	King & Queen Co., VA	Forest	2,4,5-T	?-1978	300 lbs/yr (Calculated)	150 acres	2 lbs/acre	Unknown; probably spray
	Matthews Co., VA	Forest	2,4,5-T with 2,4-D	?-1978	40 lbs/yr (Calculated)	20 acres	2 lbs/acre	Unknown; probably spray
IV	Cleveland, MS	Ricefield	2,4,5-T	1978, 1981, 1984	unknown	unknown	1 qt/acre	unknown
	Boyle, MS	Ricefield	No information available	unknown	unknown	unknown	unknown	unknown

Table 4-3 (continued)
Tier 5 Site Characterization

Region	Name of Site	Site Use	Pesticide Applied	Date(s) Treated	Volume Applied	Area Applied	Rate of Application	Type of Application
IV (cont.)	Scot, MS	Ricefield	2,4,5-T	1984	unknown	unknown	unknown	unknown
	West Palm Beach, FL	Sugarcane Field	Silvex	unknown	unknown	unknown	unknown	unknown
	Escambia Exp. Brewton, AL	Forest	2,4,5-T	1957	unknown	unknown	unknown	Aerial spray
V	Petenwell Flowage, WI	Carp Fishery; closed since 1983	Trichlorophenate	? - 1980	9,000 lbs	Pulp and Paper mills upstream	unknown	paper mill biocide
VI	Assumption Parish, LA	Sugarcane	Silvex	1982	unknown	8.1 acres	2 lbs/acre	spray from ground rig
	Pointe Coupee Parish, LA	Sugarcane field (soybeans in 1985)	Silvex	1983	unknown	2 fields, 2.6 acres and 2.7 acres	2 lbs/acre	spray from ground rig
	U. of Arkansas Experimental Station Desha County, AR	Ricefield (soybean in rotation)	2,4,5-T	1972, 1974 1975	15 lbs each field (calculated)	2 fields, 20 acres each	0.75 lbs/ acre	Aerial spray
	New Mexico State Univ. Expt. Ranch Dona Ana Co., NM	Rangeland	2,4,5-T Silvex	1968 1984	400 lbs Unknown	800 acres 4000 acres	0.5 lbs/acre unknown	Aerial spray Aerial spray
	Madison Parish, LA	Ricefield	2,4,5-T	1982, 1983	25 gal (1982); 17.5 gal (1983) (calculated)	200 acres (1982) 140 acres (1983)	1/8 gal/acre	Aerial spray
	Rio Grande Plain Experimental Ranch, Kinney Co., TX	Rangeland	2,4,5-T	1981	2.5 lbs	experimental application- 3 plots approx. 5 acres	0.5 lb/acre	Aerial spray

Table 4-3 (continued)
Tier 5 Site Characterization

Region	Name of Site	Use	Pesticide Applied	Date(s) Treated	Volume Applied	Area Applied	Rate of Application	Type of Application
	Oklahoma Rangeland Tillman Co., OK	Rangeland	2,4,5-T	1980, 1984	93 lbs	93 acres	1 lb/acre	Aerial spray
	Richland Parish, LA	Ricefield	2,4,5-T	1982 (once); 1983 (twice)	22 gal. total (calculated)	40 acres (1982); 65 and 72 acres (1983)	1/8 gal/acre	Aerial spray
VII	Mark Twain National Forest, MO	Forest	2,4,5-T	1977	190 lbs (est.)	3 sites, 95 acres total[4]	2 lbs acid equiv/acre	ground spray
IX	Tonto National Forest, AZ	Forest	2,4,5-T; 2,4-D Silvex	1965-1966; 1968-1969[5]	5400 lbs 2,4-D and 2,4,5-T; 7260 lbs silvex	Greater than 2560 acres	2 lbs acid equiv./acre	Aerial spray
	North California Rice Growing Areas	Ricefield	2,4,5-T and Silvex	Before 1971 thru 1982	117,000 lbs Silvex 37,000 lbs 2,4,5-T	8 counties over 8 counties	unknown	Spray
	Santa Ana River, CA	Multiple uses	No information available	unknown	unknown	unknown[6]	unknown	unknown
X	Santiam State Forest, Gates, OR	Forest	2,4,5-T and 2,4-D	1976-1977	unknown	75 acres	2 lbs acid equiv./acre	Spray

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[1] Max. depth of lake: 7 ft.

[2] Lake was partially drained in 1982; Now about 1/3 the size of original lake, 4-5 ft deep.

[3] Area was sprayed with several pesticides (including 2,4,5-T in 1977) from 1975 to 1983.

[4] Sampled areas include portion of the site where 2,4,5-T was sprayed and where surface runoff from the sprayed sites would drain.

[5] Initial spraying in 1965 and 1966; maintenance spraying in 1968 and 1969.

[6] Sampled area represents points where runoff from ricefields use areas could impact river water quality.

Twenty-two soil samples that were collected approximately 2 feet from the ends of the rail ties were analyzed. Eighteen of the 22 samples contained 2,3,7,8-TCDD at levels ranging from 8 to 35 ppt.

No additional action is planned at this time. The contamination found is in the ballast or subgrade areas of an active railroad and thus presents minimal risk.

Region II: Long Island Railroad, NY

This railroad right-of-way was treated with 2,4,5-TCP-based herbicides during the 1970s.

A 480-foot long section along the tracks was sampled. Twenty-six samples were collected 13 feet from each end of the tracks. One sample contained 2,3,7,8-TCDD at a level of 9 ppt.

No additional action is planned.

Region IV: Cleveland, MS

This rice field was treated with 2,4,5-T in 1978, 1981, and 1984.

Twenty random soil samples were collected from a recently harvested field (60-100 acres). Sixteen samples contained 2,3,7,8-TCDD at levels ranging from 0.8 to 1.7 ppt.

No additional action is planned.

Region IV: Scot, MS

This rice field was treated with 2,4,5-T in 1984.

Twenty random soil samples were collected from a recently harvested field (60-100 acres). Two samples contained 2,3,7,8-TCDD at levels of 0.6 and 0.7 ppt. No 2,3,7,8-TCDD was detected in the one rice sample.

No additional action is planned.

Region IV: West Palm Beach, FL

These sugarcane fields were treated with silvex for weed control around the perimeter of the fields.

Sampling was not permitted directly on the sugarcane fields so sediment samples were collected from canals adjacent to the fields. Twenty-seven of 36 collected sediment samples contained 2,3,7,8-TCDD at levels ranging from 0.7 to 26.5 ppt.

The EPA has notified the State of Florida's Pesticide Enforcement Division of Inspection, Department of Agriculture and Commerce Services, of the results.

Region V: Petenwell Flowage, WI

This 23,000-acre reservoir on the Wisconsin River supported a major commercial carp fishery until 1983 when 2,3,7,8-TCDD was detected in carp at levels above 50 ppt. Chlorophenol-based slimicides, reportedly containing 2,3,7,8-TCDD as a contaminant, had previously been used by several pulp and paper mills along the river. Usage of these slimicides had been voluntarily stopped by the mills by 1980.

Whole fish and filets from several species, fatty tissue from raccoons, aquatic bird tissue and eggs, aquatic sediments, and sludges from the paper mills were sampled. Also, an information request was directed to each of the facilities in order to acquire more detail regarding past slimicide usage and sludge disposal practices.

All sampled fish contained 2,3,7,8-TCDD with levels from 9 to 47 ppt in the whole fish and 3 to 23 ppt in the filets. Aquatic sediments at both ends of the reservoir contained 2,3,7,8-TCDD at levels from 35 to 200 ppt. A raccoon fat sample contained 2,3,7,8-TCDD at 1.9 ppt and four aquatic bird tissue samples contained levels from 0.76 to 12 ppt. Two of the paper mills are still producing sludges with 2,3,7,8-TCDD levels over 100 ppt, even though chlorophenol-based slimicides are no longer used. A recently identified potential source of 2,3,7,8-TCDD is the chlorine bleaching process.

As a result of these findings, additional work is being conducted at this site with particular interest in determining the cause of 2,3,7,8-TCDD sludge contamination as well as environmental conditions at and near the sludge disposal sites. The industry has begun follow-up studies under state direction.

Region VI: Assumption Parish, LA

This 2,500-acre site, used for growing sugarcane, was treated with silvex in 1983.

Twenty-four soil samples were randomly collected from eight acres. Fourteen samples contained 2,3,7,8-TCDD at levels between 0.3 and 1.1 ppt.

No additional action is planned.

Region VI: Desha County, AR

This experimental agricultural station specializes in rice reproduction, with soybeans grown in rotation. Two 20-acre fields at this site were aerially sprayed with 2,4,5-T. One field was treated with 2,4,5-T in 1972, 1974, and 1975, and the other was treated in 1975 only.

Forty-six samples were randomly collected from the two fields and associated drainage ditches. One sample contained 2,3,7,8-TCDD at 3 ppt from the field, which had been treated three times. No 2,3,7,8-TCDD was detected in the five plant tissue samples or the three drainage ditch samples.

No additional action is planned.

Region VI: Richland Parish, LA

Approximately 70 acres of this rice field were treated with 2,4,5-T, with one application in 1982 and two applications in 1983.

Thirty-five samples and one sediment sample were randomly collected; 2,3,7,8-TCDD was detected in nine soil samples at levels between 0.3 and 0.4 ppt. No 2,3,7,8-TCDD was detected in the sediment sample.

No additional action is planned.

Region VI: Pointe Coupee Parish, LA

This site, used for growing sugarcane prior to 1985 and soybeans in 1985, was treated with silvex in 1983.

Twenty-five soil samples were randomly collected from two fields, 2.6 acres and 2.7 acres in area. Twenty samples contained 2,3,7,8-TCDD at levels ranging from 1.0 to 2.5 ppt.

No additional action is planned.

Region VI: Rio Grande Plain Experimental Ranch, Kinney Co., TX

This site is an experimental ranch used for research on brush control and livestock production. In 1981, parts of three experimental pastures (5 acres each) were aerially sprayed with 2,4,5-T. Parts of each were left untreated as controls.

Thirty-eight soil samples were randomly collected from the three pastures among the treated and untreated areas. Twelve samples (five from treated areas and seven from untreated areas) contained 2,3,7,8-TCDD at levels between 0.2 and 3 ppt. No 2,3,7,8-TCDD was detected in a rattlesnake sample or six vegetation samples collected from the sprayed pastures.

No additional action is planned.

Region VII: Mark Twain National Forest, MO

The herbicide 2,4,5-T was applied in 1977 to three sites totaling approximately 95 acres within the forest to facilitate the relief of shortleaf pines from competing hardwoods. A tractor-drawn, high-volume ground spray tanker unit was used to apply the herbicide.

A total of 50 soil samples were collected from two sub-areas at one of the three treated sites. These areas were located at the bottom of slopes where herbicide runoff would tend to accumulate. Twenty-one of the 50 soil samples contained 2,3,7,8-TCDD at levels between 0.3 and 120 ppt.

No additional action is planned at this time since the area is not used for grazing.

Region IX: Tonto National Forest, AZ

Between 1965 and 1969, 2,4,5-T, 2,4-D, and silvex were sprayed over more than 2,500 acres in the Globe Ranger District. This spraying project was designed to improve rangeland and to increase water runoff, resulting in increased water yields for downstream users.

Soil samples were collected from three helicopter landing areas used as herbicide mixing-loading areas and from five other locations within the sprayed area. Whole animals and animal tissue samples were also collected within the sprayed areas. Twenty-four of 77 soil samples had 2,3,7,8-TCDD at levels of 2 to 564 ppt. Soil contamination was found at two of the three mixing-loading areas. (The mixing-loading area where no 2,3,7,8-TCDD was found was later determined not to have been used for that purpose.) 2,3,7,8-TCDD was detected a short distance beyond the boundaries of the actual mixing-loading locations. No 2,3,7,8-TCDD was detected in any of the animal tissue samples.

Forty-five additional samples, which included soil and fish, were collected from three additional and one previously sampled mixing-loading area. Twenty-one soil samples contained 2,3,7,8-TCDD at levels from 0.4 to 6623 ppt. Four samples had levels greater than 1000 ppt. No 2,3,7,8-TCDD was detected in the fish collected.

The U.S. Forest Service has restricted access to the contaminated helicopter-loading areas.

Region IX: Santa Ana River, CA

The Santa Ana River Basin includes agricultural, industrial, and residential areas.

Twenty-eight sediment samples were collected from stations along the Santa Ana River and a few of its tributaries. These locations have been routinely monitored for conventional and priority pollutants. Fish samples were collected at eight of the sediment stations where water flow was sufficient to support fish. One sediment sample contained 0.6 ppt of 2,3,7,8-TCDD, and one of the nine whole fish contained 4.6 ppt of 2,3,7,8-TCDD.

Region X: Santiam Forest, Gates, OR

A 75-acre area of this forest site was aerially sprayed with an herbicide containing 2,4-D and 2,4,5-T in 1976 and 1977.

Twelve sediment samples were collected from a stream that runs through the sprayed area, an area where this stream empties into the North Santiam River, and an area of the North Santiam River near the confluence with the stream. Thirty-five soil samples were collected from a wetlands area south of the sprayed area, a heliport used by helicopters that sprayed the area, and the heliport drainage area. One fish sample was collected from the North Santiam River sampling area. 2,3,7,8-TCDD was detected in 3 of 12 sediment samples at levels of 0.2 and 0.4 ppt. No 2,3,7,8-TCDD was detected in the 35 soil samples or the one fish sample.

4.2.4 Findings

- Contamination was found at a variety of the sites sampled where 2,4,5-T, silvex, and 2,4,5-TCP-based pesticides were used and in various media (soil, sediment, and fish). However, the levels found were generally very low.
- The highest levels for each media were generally found where sampling was targeted for specific areas most likely to be contaminated (areas used for equipment loading or where contaminants would tend to accumulate).
- Levels were much lower, in most cases not detected, for samples in areas where the pesticides were uniformly applied (spray areas).

- 2,3,7,8-TCDD was more frequently detected and was occasionally at higher levels at Tier 5 sites than at background sites (Tier 7).

- Two of the seven sites where fish were collected had detectable levels of 2,3,7,8-TCDD; whole fish were contaminated at levels up to 47 ppt in the Petenwell Flowage.

- Sludges from two paper mills on the Petenwell Flowage were found to have levels of 2,3,7,8-TCDD over 100 ppt, even though chlorophenol-based slimicides are no longer used.

4.2.5 Conclusions

- With the exception of helicopter-loading areas in the Tonto National Forest, the levels found at Tier 5 sites where spraying of pesticides occurred were below relevant levels of concern; further national investigation of Tier 5 spray areas does not appear to be warranted.

- The current source of 2,3,7,8-TCDD at the most significantly contaminated Tier 5 site (Petenwell Flowage) may not be related to slimicide use in pulp and paper mills. As described in greater detail under the Tier 7 discussion, further investigations of certain types of pulp and paper mills using the chlorine bleaching process are being conducted.

4.3 Tier 6

4.3.1 Objective

Tier 6 consisted of organic chemical and pesticide manufacturing facilities where improper quality control on production processes could have caused products or waste streams to become contaminated with 2,3,7,8-TCDD. Dioxins (EPA, 1980) identified 125 organic and pesticide compounds whose production could inadvertently create dioxin based on their molecular structure, process sequence, and commercial significance. The production of 60 of these compounds is most likely to lead to dioxin formation, according to Dioxins. Facilities producing any of these 60 compounds (Table 4-4) were identified as Tier 6 candidates.

The objective of the Tier 6 sampling program was to determine the percentage of identified facilities that are contaminated with 2,3,7,8-TCDD above 1 ppb in soil or at any detectable level in other environmental media (e.g., fish in nearby streams). The detection limits for other media, and therefore the levels that determine whether contamination is present, vary slightly from site to site.

4.3.2 Methods

Site Selection

Initially, the EPA identified 61 facilities that manufacture one or more of the compounds shown in Table 4-4. Four sources of information were used to identify these facilities:

- Directory of Chemical Producers (SRI, 1977-1983);
- FIFRA and TSCA Enforcement System (FATES);
- Dioxins (EPA, 1980); and
- EPA regional office staff suggestions.

Nineteen facilities were initially selected for sampling. (Appendix C presents detailed selection procedures.) One facility was selected twice and is replicated in the sample data set used for estimating the results for the entire tier.

Six additional facilities were identified in the FATES data base after the initial 19 facilities were selected. Rather than rework the selection model to account for the additional plants, all six plants were selected for sampling, giving a total of 25 statistically selected sites to represent 67 facilities. (The facilities producing only brominated Tier 6 compounds were later considered ineligible as an investigation of the production process

TABLE 4-4

TIER 6 COMPOUNDS AND NUMBER OF SAMPLED SITES

General Name	Chemical Name	Number of Facilities Sampled[a]	Number Contaminated
Pesticides			
Bifenox	Methyl-5-(2,4-dichlorephenoxyl)-2 nitrobenzoate		
Chloranil[b]	2,3,5,6-Tetrachloro-2,5-cyclohexadiene-1,4-dione		
2,4-D and esters & salts	(2,4-Dichlorophenoxy)acetic acid and esters & salts	2(s)	(1)
2,4-DB and salts	2,4-Dichlorophenoxybutyric acid and salts	1(s)	
Dicamba	3,6-Dichloro-2-methoxybenzoic acid		
Dicamba, dimethylamine salt	3,6-Dichloro-2-methoxybenzoic acid dimethylamine salt		
Dicapthon	Phosphorothioic acid o-(2-chloro-4-nitrophenyl) o,o-dimethyl ester		
Dichlofenthion	Phosphorothioic acid o-2,4-dichlorophenyl o,o-diakyl ester	1(s)	
Disul sodium (sesone)	2,4-Dichlorophenoxyethyl sulfate, sodium salt		
2,4-DP	2-(2,4-Dichlorophenoxyl) propionic acid		
Nitrofen	2,4-Dichlorophenyl-p-nitrophenyl ether		
Pentachlorophenol (PCP) & salts	Pentachlorophenol and salts	3(s)	(1)
. . . .	o-Benzyl-p-Chlorophenol	1(s)	
. . . .	2,3,4,6-Tetrachlorophenol	1(s)	
Bromoxynil and esters	3,5-Dibromo-4-hydroxybenzonitrile		
Carbonphenothion	Phosphorodithioic acid s-(([4-chlorophenyl] thio) methyl) o,o-diethyl ester	1(r)	(1)
DCPA	2,3,5,6-Tetrachloro-1,4-benzenedicarboxylic acid dimethyl ester		
Dichlone	2,3-Dichloro-1,4,naphthalenedione		
Dinitrobutylphenol, ammonium salt	2,4-Dinitro-6-sec-butyl phenol, ammonium salt		
Loxynil	3,5-Diiodo-4-hydroxybenzonitrile		
Lindane	1,2,3,4,5,6-Hexachlorocyclohexane, gamma isomer	2(r)	(1)
MCPA	(4-Chloro-o-toloxy) acetic acid		
MCPB	4-(2-Methyl-4-chlorophenoxy) butyric acid		
Mecoprop	2-(4-Chloro-2-methylphenoxy) propianic acid	1(s)	(1)
Parathion	Phosphorothioic acid o,o-diethyl o-(4-nitrophenyl) ester	1(s)	
PCHP	Pentachloronitrobenzene		
. . . .	Pipecolinopropyl-3-4-dichlorobenzoate		
Piperalin	3-(2-Methylpiperidino)propyl-3-4-dichlorobenzoate	1(s)	
Propanil	3,4-Dichloropropionanilide	1(s)	
Tetradifon	1,2,4-Trichloro-5-([4-chlorophenyl]-sulfonyl) benzene		
. . . .	2,3,6-Trichlorobenzoic acid	1(s)	
. . . .	2,3,6-Trichlorophenylacetic acid and sodium salt	1(s)	
. . . .	Triiodobenzoic acid	1(s)	

TABLE 4-4 (continued)

TIER 6 COMPOUNDS AND NUMBER OF SAMPLED SITES

General Name	Chemical Name	Number of Facilities Sampled[a]	Number Contaminated
Organic Chemicals			
	4-Bromo-2,5-Dichlorophenol		
	2-Chloro-4-Fluorophenol		
	Decabromophenoxybenzene		
	2,4-Dibromophenol		
	2,3-Dichlorophenol	1(r)	
	2,4-Dichlorophenol		
	2,5-Dichlorophenol		
	2,6-Dichlorophenol	1(r)	
	3,4-Dichlorophenol		
	Pentabromophenol		
	2,4,6-Tribromophenol		
	Bromophenetole		
	o-Bromophenol		
	2-Chloro-1,4-Diethoxy-5-Nitrobenzene		
	5-Chloro-2,4-Dimethoxy-Aniline		
	Chlorohydroquinone		
	o-Chlorophenol		
	2-Chloro-4-Phenyl phenol		
	4-Chlororesorcinol		
	3,5-Dichlorosalicylic Acid		
	2,6-Dibromo-4-Nitrophenol		
	3,5-Diiodosalicylic Acid		
	2,6-Diiodo-4-Nitrophenol		
	o-Fluoroanisole		
	o-Fluorophenol		
	Tetrabromobisphenol-A		
	Tetrabromobisphenol-B		

Note: Includes all salts and esters of these compounds.

[a] Production information is available for 11 of 15 sampled, eligible, statistically selected sites, and 3 regionally selected sites.
s = statistically selected site
r = regionally selected site

[b] A statistically selected orthochloranil production facility was considered ineligible, as an evaluation of its production process revealed that 2,3,7,8-TCDD could not be formed.

Note: Facilities producing only brominated Tier 6 compounds were considered ineligible, as an investigation of the production of brominated compounds revealed that 2,3,7,8-TCDD could not be formed.

for brominated compounds revealed that 2,3,7,8-TCDD could not be formed.)

The regional offices identified three additional facilities of particular interest for sampling based on known activities at the facility or previous contamination incidents. The results for these facilities are presented separately in this report and are not used in the statistical analysis for the tier.

Sampling Locations

The approach to sampling Tier 6 sites was identical to that described for Tier 3.

4.3.3 Results

Site Characteristics

Of the 25 statistically selected sites, 10 were considered ineligible (Table 4-5), because further information revealed that no Tier 6 compounds that could cause 2,3,7,8-TCDD to be formed were actually produced. A total of 13 of the Tier 6 compounds were produced by the statistically selected facilities (Table 4-4). Most of these compounds were produced at one selected site only. An additional four Tier 6 compounds were produced at the three regionally selected facilities (Table 4-4).

Waste generation and disposal information is available for 11 statistically selected sites and for all 3 regionally selected sites. Of the 11 statistically selected sites, 10 generated process wastewater and 7 generated solid waste (6 generated both). Six of the 10 facilities generating wastewaters discharge off-site, including 3 that discharge to surface waters and 4 that deep-well inject (one did both). All seven of the facilities generating solid wastes disposed of at least some of their waste off-site, primarily in landfills. Two of the three regionally selected sites disposed of solid waste both on-site and off-site and liquid waste on-site. The third generated no waste.

Analytical Results and Discussion

Contamination (soil concentrations greater than or equal to 1 ppb or detectable levels in other media) was found at 2 of the 15 statistically selected eligible sampled sites (Table D-4, Appendix D). Two additional sites had 2,3,7,8-TCDD concentrations in soil below 1 ppb (Figure 4-4).

The estimate of the percentage of facilities in the various data bases that are actually eligible Tier 6 sites is 67 ± 42 percent. The estimate of eligible facilities that would be found contaminated is 14 ± 10 percent (Appendix C). The estimate of

TABLE 4-5

STATISTICALLY SELECTED TIER 6 SITES THAT WERE INELIGIBLE

Site

Region II
  United Guardian, Inc.
  Hauppage, NY

  International Minerals and Chemical*
  Newark, NJ

Region IV
  Alpine Labs., Inc.
  Minette, AL

  Olin Corp.
  Leland, MS

  Martin Marietta (Sandox)**
  Charlotte, NC

Region V
  Northwest Ind., Inc.
  St. Louis, MI

  Sherwin Williams Co.**
  St. Bernard, OH

Region VII
  Monsanto Co.
  Muscatine, IA

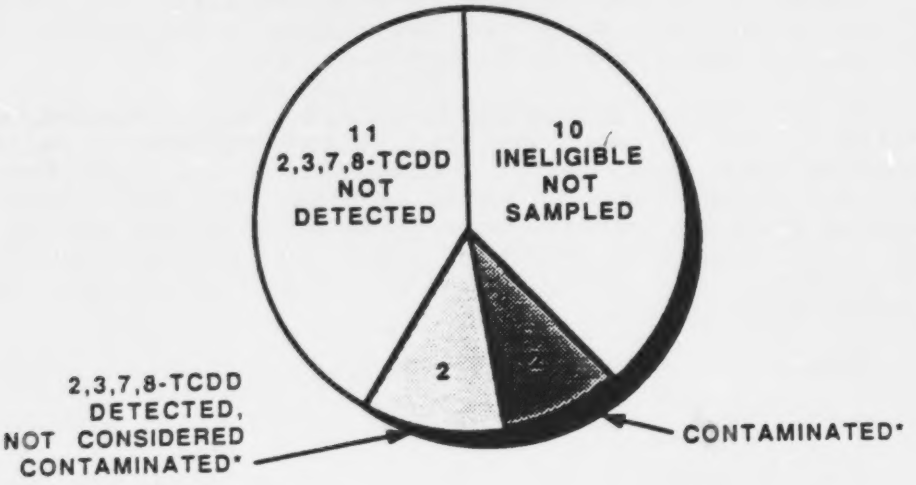
  Mobay Chemical Corp
  Kansas City, MO

Region VIII
  Arrapahoe (Syntex)
  Boulder, CO

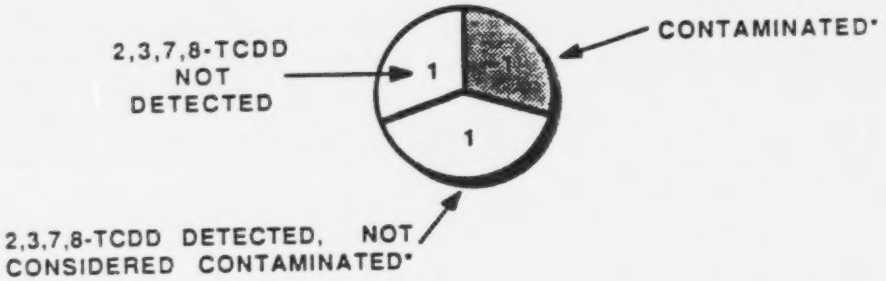
* Has been designated as a Tier 1A or 2A site.

** Produced brominated compounds.

25 STATISTICALLY SELECTED SITES



3 REGIONALLY SELECTED SITES



*A SITE WAS CONSIDERED CONTAMINATED IF ANY SOIL SAMPLE CONTAINED MORE THAN 1 ppb OF 2,3,7,8-TCDD OR IF ANY SAMPLE FROM ANOTHER MEDIUM (FISH OR SEDIMENTS FROM ADJACENT STREAM,GROUNDWATER) CONTAINED A DETECTABLE LEVEL OF 2,3,7,8-TCDD. DETECTION LIMITS FOR OTHER MEDIA WERE APROXIMATELY 1 ppt EXCEPT FOR WATER FOR WHICH THE DETECTION LIMIT WAS APPROXIMATELY 10 ppq.

FIGURE 4-4. DISTRIBUTION OF CONTAMINATION AT TIER 6 SITES

all 67 facilities identified in the data bases that would be found contaminated is 9 percent (95 percent confidence range 3-19 percent).

One of the three regionally selected sites was contaminated, and one additional site had detectable 2,3,7,8-TCDD levels in soil below 1 ppb (Table D-5, Appendix D).

At all three contaminated sites, soil contamination was limited to one or two samples. At the regionally selected contaminated site, groundwater contamination was also found at the 0.07 to 0.10 ppt level in three samples. The EPA's water quality criteria document reports an increased lifetime cancer risk of 1 in 1 million from drinking water containing 0.000022 ppt of 2,3,7,8-TCDD. The groundwater in this case is not used as a drinking water source.

Discussion of Contaminated Sites

Region II: *W.A. Cleary - Somerset, NJ

This facility, located on 137 acres, produced mecoprop and 2,4-D salts from 1977 to 1983. During this time an estimated 10,000 gallons per year of liquid waste were discharged to an on-site lagoon.

Thirty-one soil samples were collected: 21 at the areas around the production buildings and the lagoon and 10 random samples from the remainder of the property, which includes a densely wooded area and the company's golf course. One soil sample collected near a production building (below a loading dock) contained 2,3,7,8-TCDD at 34.7 ppb. One sediment sample was collected from the lagoon, but 2,3,7,8-TCDD was not detected.

This site has been referred to the Superfund Program for further sampling.

Region VI: *Chemall, Inc. (Riverside Chemical) - Port Neches, TX

This facility is located on 14.19 acres, with the manufacturing facility situated on 11.9 fenced acres within the tract. A former operator of the facility (Riverside Chemical) produced pentachlorophenol (PCP) at this site prior to the facility's purchase by Chemall, Inc. in 1978. In addition, a number of organic chemicals, including 2,4,5-T (a Tier 3 chemical), 2,4-D, and parathion (both Tier 6 chemicals), have been stored at this site. As a result of a 1976 Texas Water Quality Board enforcement

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"*" denotes a statistically selected site.

order, Riverside removed soils contaminated with PCP and toxaphene and covered areas around the processing facilities, warehouse, office, and railroad spur with approximately 1 to 2 feet of crushed limestone.

Thirty-two soil samples were collected from drainage ditches, including those from the former PCP process and storage area, and from locations near unloading and storage areas. Many of these samples were taken from beneath pools of standing water, and about half were taken outside the fenced area. 2,3,7,8-TCDD was detected in nine samples, with two samples containing greater than 1 ppb (1.1 ppb and 1.4 ppb). These two samples were collected from the tank car unloading area and the drainage ditches behind the central warehouse, where 2,4,5-T, 2,4-D, parathion, and other chemicals were stored. The runoff area from the former PCP process and storage area contained 2,3,7,8-TCDD at levels below 1 ppb.

The Texas Water Commission (TWC) currently has Chemall under an enforcement order to undertake remedial action relating to contamination found on site and in adjacent ditches. All areas where 2,3,7,8-TCDD was detected will be addressed in the TWC's enforcement action. The TWC will coordinate with the EPA Region VI to assure compliance with the EPA's dioxin regulations.

Region IX: BMI Complex - Henderson, NV

This industrial complex covers more than 350 acres and includes the Stauffer Chemical Company and its subsidiary, the Montrose Chemical Corporation.

The Stauffer facility produced lindane from 1948 to 1956, ethyl and methyl parathion intermittently since 1958, and carbophenothion. Alpha and beta BHC were produced as waste products from the production of lindane. The waste BHC was disposed of in a surface pile, which was capped with a 1-foot layer of clay in 1978-1979. Prior to 1974, aqueous wastes from the production of carbophenothion were disposed of in on-site leach beds, and drums containing still bottoms from the carbophenothion process were buried on site. Both areas have been capped with a 1-foot clay layer. After 1974, carbophenothion wastes were disposed of in on-site lined ponds or in an off-site landfill.

Montrose Chemical produced chlorobenzenes at this site from 1947 to 1983. From 1947 to 1976, polychlorinated benzene wastes (still bottoms) were disposed of in the on-site BMI dump. From 1976 to 1983, the polychlorinated benzene wastes were disposed of in a lined pond. In 1980, the still bottoms from this pond were transferred to a storage tank.

Thirty-seven soil samples were collected from chemical production, storage and loading areas, associated drainage areas, and areas adjacent to former waste disposal locations. 2,3,7,8-TCDD was detected at 1 ppb in one soil sample taken down-gradient from the chlorobenzene still bottom disposal area. Seven groundwater samples were also collected from Stauffer's groundwater intercept and treatment system. 2,3,7,8-TCDD was detected in four of these samples at levels ranging from 0.07 to 0.11 ppt. Other dioxin isomers were also detected, but not quantified.

Montrose Chemical's use of caustic soda in its former production of chlorobenzene may account for the levels of 2,3,7,8-TCDD. (Chlorobenzenes were not included as Tier 6 compounds because it was not suspected that 2,3,7,8-TCDD could be formed during their normal manufacture.) The 2,3,7,8-TCDD detected in groundwater may have been brought into solution by benzene and chlorobenzenes disposed on site.

Additional soil, water, and waste samples have been collected. However, analysis of these samples has been delayed until analytical difficulties have been resolved (complex mixtures of chlorinated products).

4.3.4 Findings

- The EPA estimated that 9 percent of the 67 facilities originally identified as Tier 6 sites would be found contaminated.

- None of the three contaminated sites were extensively contaminated with 2,3,7,8-TCDD.

4.3.5 Conclusion

- Further national investigation of Tier 6 sites for 2,3,7,8-TCDD does not appear to be warranted.

4.4 Tier 7

4.4.1 Objectives

Tier 7 consisted of sites that did not have any previously known sources of 2,3,7,8-TCDD contamination. The Tier 7 investigation was intended to establish the prevalence of 2,3,7,8-TCDD in soil and fish at the ppt level of detection, and to provide a basis for comparison with results from the other tiers.

The specific objectives of the Tier 7 sampling program were to:

- Determine the percentage of sites in the EPA Urban and Rural Soil Networks that have detectable levels of 2,3,7,8-TCDD in soil at a detection limit of approximately 1 ppt; and
- Determine the percentage of sites in the combined U.S. Geological Survey's (USGS) National Stream Quality Accounting Network (NASQAN) and Benchmark Network that have detectable levels of 2,3,7,8-TCDD in fish tissue at a detection limit of approximately 1 ppt.

The EPA regional offices also selected a large number of additional fish sampling sites in areas of general interest, including areas near population centers, recreational or commercial fishing areas, or historical sampling areas.

4.4.2 Methods

Site Selection - Soils

Soil sampling locations were chosen from the Rural and Urban Soils Networks of the National Soils Monitoring Program, which was established to monitor pesticide residues in rural and urban soils. The Rural Soils Network consists of 13,280 rural sites identified in the 1967 Conservation Needs Inventory of rural land areas within the contiguous United States. A cluster sample approach was used to randomly select 200 sites from this network (Appendix C). A similar approach was used to select 300 urban soil sites from the Urban Soils Network, which is comprised of 1,761 sites in 20 Standard Metropolitan Statistical Areas. One soil sample was taken per site.

The Rural Soils Network and the Urban Soils Network both have unknown probability structures and thus cannot be considered representative of the soils in the U.S. Therefore, the results from this study can be used only to provide estimates describing the soils in the networks.

Site Selection - Fish

One hundred fish sampling sites were statistically selected from the 554 sites in combined USGS NASQAN and Benchmark Networks (Appendix C). In addition, 305 sites suggested by the OWRS or EPA regional offices were also chosen for sampling based on proximity to population centers, commercial or recreational fishing activity, or availability of historical water quality information. Of these, 73 were in the USGS networks; the results from them were combined with the 100 statistically selected sites for statistical extrapolation to the combined NASQAN and Benchmark Networks.

Protocols were defined to limit fish and sample collection variables among sites as described in the sampling guidance document. Target species were specified to reduce interspecies variations; fish of similar age were sampled where possible; and the time of sampling was limited to reduce seasonal variations, such as weight loss during spawning.

Four composite samples per site were collected: 1) a whole bottom-feeding fish, 2) a bottom-feeding fish filet, 3) a whole predator or game fish, and 4) a predator or game fish filet. Whole fish composites of bottom feeders were analyzed first because data indicate that 2,3,7,8-TCDD concentrations are likely to be highest in those samples. If 2,3,7,8-TCDD was detected in a whole fish bottom feeder sample, then the other three samples from that site were analyzed. Because of differences in species, age, or fat content of the fish being composited for each separate analysis, it is possible that the highest level found at a site could be in a sample other than the whole bottom-feeding fish.

Sampling Locations

In Tier 7, the site locations were the sampling locations.

4.4.3 Results

Site Characteristics

From the soil networks, 141 of the 200 statistically selected rural soil sites and 221 of the 300 statistically selected urban sites were sampled. The remaining 59 rural sites and 79 urban sites could not be sampled because their locations could not be precisely identified (131 sites), or because permission to collect a sample was denied (7 sites). Of the 100 statistically selected fish sampling sites, 90 were sampled. The remaining 10 sites could not be sampled because of lack of water, fish, success in catching fish at the time sampling was attempted, or dangerous access to the site (Table 4-6).

TABLE 4-6

STATISTICALLY SELECTED TIER 7 SITES THAT COULD NOT BE SAMPLED

REGION I

Wild River at Gilead, ME

REGION II

McDonalds Branch in Lebanon State Forest, NJ

REGION IV

Falling Creek near Juliett, GA

REGION V

Upper Twin Creek at McGaw, OH
Bad River at Odanak, WI

REGION VI

North Canadian River at Woodward, OK
Double Mtn. Fork Brazos River Near Asperment, TX
Rio Grande at Brownsville, TX

REGION IX

Quinn River near McDermitt, NV

REGION X

Queets River near Clearwater, WA

Analytical Results and Discussion

Urban Soils

Seventeen of the 221 samples in the Urban Soils Network were found to have detectable levels of 2,3,7,8-TCDD (Table D-6, Appendix D). The EPA's best estimate is that 8 percent of the sites would have detectable levels of 2,3,7,8-TCDD, although the large number of missing sites (79) means that the 95 percent confidence range is from 6 to 32 percent of the network sites would have detectable levels of 2,3,7,8-TCDD (Appendix C).

Levels of 2,3,7,8-TCDD in the 17 positive samples were very low, between 0.2 and 11.2 ppt; seven of the 17 samples were less than 1 ppt. By comparison, 2,3,7,8-TCDD levels in soil at Times Beach, MO, a Tier 1 disposal site that was permanently evacuated, ranged up to greater than 1,000 ppb (1,000,000 ppt). These soils were sprayed for dust control with a mixture of waste oil and concentrated waste sources containing 2,3,7,8-TCDD. Also, all 32 soil samples collected in public use and residential areas in Midland, MI, near the Dow Chemical facility (also a Tier 1 site) showed 2,3,7,8-TCDD contamination. The range of soil contamination was between 3 and 76 ppt in open public and residential areas and up to 270 ppt beneath downspouts in residential areas (EPA, 1985a). Historical air emissions from Dow Chemical's hazardous waste incinerator and other less significant sources were identified as the likely sources of 2,3,7,8-TCDD in Midland soils. Two additional urban areas were sampled during the Midland study as a basis for comparison, and the results from these two areas were similar to the results from the Tier 7 urban sites (2,3,7,8-TCDD infrequently detected and at low levels), even though these samples consisted of 0.5 to 1-inch deep cores as compared to the 4 inch deep cores for Tier 7 samples.

Rural Soils

Only one of the 138 samples from the Rural Soils Network contained 2,3,7,8-TCDD, and the concentration was only 0.5 ppt (Table D-7, Appendix D). (Samples for three sites were not analyzed because they were either lost or broken during shipment. These samples were considered missing for the purpose of statistical estimation.) The EPA's best estimate is that less than 1 percent of the rural sites would have detectable levels of 2,3,7,8-TCDD, although the large number of sites that could not be sampled (59) means that the 95 percent confidence range is from 0.5 to 23 percent (Appendix C). Similarly, surface soil samples (0.5 to 1-inch) collected in Minnesota's natural woodland and prairie areas as part of the overall Midland study had no detectable levels of 2,3,7,8-TCDD.

Fish

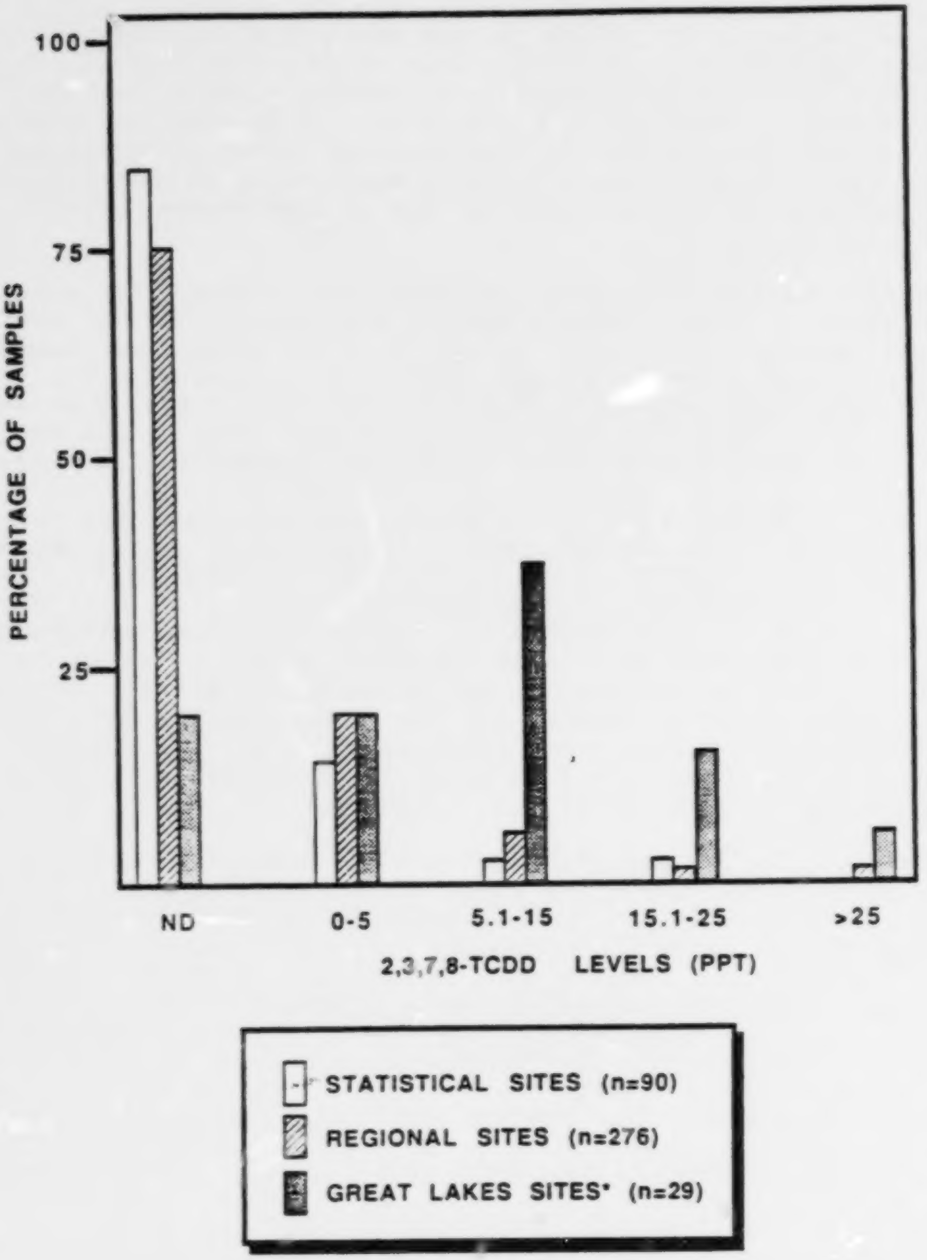
Fish from 17 of the 90 statistically selected sites had detectable levels up to 19 ppt in the whole fish composite sample (Table D-8, Appendix D). The EPA's best estimate is that 21 percent of the sites from the USGS monitoring networks would contain fish with detectable levels of 2,3,7,8-TCDD. This assumes that the unsampled sites are similar to the sampled sites in frequency of contamination. (See Appendix C for a discussion of the statistical analyses and an explanation of why a confidence interval is not presented.)

Ninety-five (31 percent) of the 305 regionally selected sites (including rivers, Great Lakes, and estuarine and coastal sites) had detectable levels in whole fish composite samples, with levels ranging up to 85 ppt (Table D-9, Appendix D). This frequency is greater than that found for the statistically selected sites; however, a possible explanation is that many of the regionally selected sites were near urban or industrialized areas.

Of the 112 sites where 2,3,7,8-TCDD was detected, the maximum value was below 5 ppt at 74 sites (67 percent), while at four sites (1 percent) levels were above 25 ppt (Figure 4-5). As a result of these findings, advisories to limit fish consumption have been issued by the States of Maine (for the Androscoggin River at Lewiston) and Minnesota (for the Rainy River at International Falls). An advisory was already in effect for fish caught in Lake Ontario because of the contamination from mirex, PCBs, and mercury. Additional sampling will be conducted at the fourth site (the Flint River at Elms Road) to verify levels and identify potential sources of 2,3,7,8-TCDD.

Twenty-three (79 percent) of the 29 sampled sites in the Great Lakes were found to have detectable levels of 2,3,7,8-TCDD, which is a much higher proportion than that found in the statistically selected or other regionally selected sites. Possible explanations for this finding include: 1) the sites were selected based on potential contamination from prior evaluation of toxic pollutants, 2) the long water retention of the lakes causes elevated pollutant levels in the system, and 3) there are many sources of pollutants entering the lakes. Areas in the lakes with higher levels are the subject of fish advisories for other chemicals. Further investigation is being conducted by the regional offices, states, and the Great Lakes National Program Office.

Only 4 of 57 estuarine or coastal sites had detectable levels in fish or shellfish, with concentrations ranging from 1.08 to 3.5 ppt. Three of the four sites with detectable levels were in heavily industrialized areas, while the fourth contaminated sample was collected from weathered, chemically-treated



*GREAT LAKES SITES INCLUDE FISH FROM OPEN WATERS AND FROM HARBOR AREAS

FIGURE 4-5. DISTRIBUTION OF 2,3,7,8-TCDD CONCENTRATIONS IN FISH (MAXIMUM LEVEL AT EACH SITE)

wood pilings. Additional analyses of shellfish attached to recent, chemically-treated pilings and artificial substrates at this site showed no detectable levels of 2,3,7,8-TCDD.

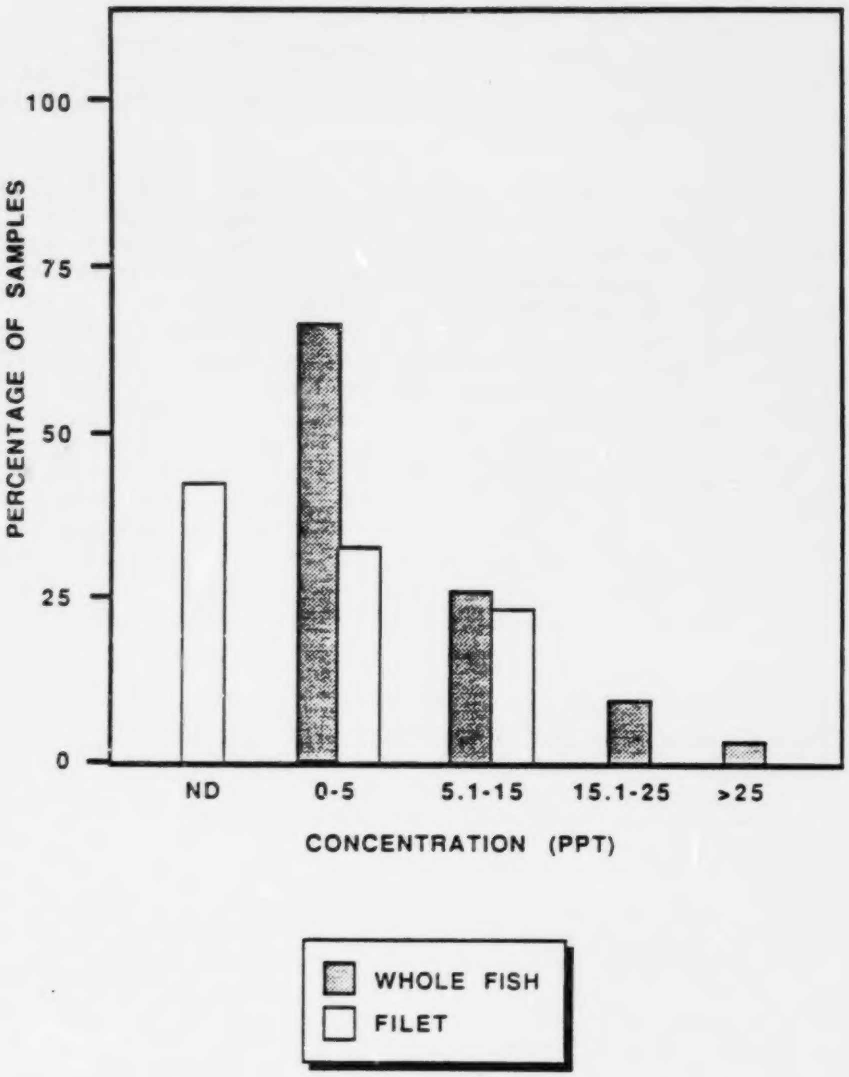
Outside of the Great Lakes, detectable levels in fish were most frequently found in major river systems, such as the Ohio and Mississippi Rivers, or in waterways with significant industrial activity.

Levels found in filet samples (between 0.4 to 41 ppt) were lower than levels in the whole fish samples at 79 of the 86 sites with both whole fish and filet data (Figure 4-6). At 46 percent of the sites where 2,3,7,8-TCDD was detected in whole fish, it was not detected in the filet sample. The levels found in fish filets may be a cause for concern under particular conditions at specific locations. For example, using the EPA cancer model and the consumption estimates from the EPA's water quality criteria document (see Table A-3, Appendix A), fish contaminated at the detection level of approximately 1 ppt could cause an increased lifetime cancer risk of 1 in 100,000. The results from Tier 7 should be carefully evaluated by local, state, and federal agencies in light of local exposure conditions in determining a level of concern. Site-specific factors include: consumption patterns (type of fish and amount consumed), length of exposure, level of contamination, and percent of fish contaminated.

The EPA used two approaches in an effort to determine possible associations between the presence of 2,3,7,8-TCDD in fish and various sources: 1) preparing stream profiles that identified types of industrial dischargers in the vicinity of the Tier 7 fish sampling sites, and 2) conducting additional sampling at selected sites.

Stream profiles were prepared that identified the major types of industrial dischargers 30 miles upstream and 3 miles downstream of the statistically selected and regionally selected fish sites; summaries of the stream profiles are presented in Tables D-10 and D-11 in Appendix D. Chemical plants and pulp and paper mills were the facilities that appeared to be most frequently associated with the detection of 2,3,7,8-TCDD in fish (Table 4-7). Certain types of chemical plants were already under investigation under Tiers 1, 2, and 6, while pulp and paper mills had not previously been suspected as a source of 2,3,7,8-TCDD.

Both of the two sites with the highest 2,3,7,8-TCDD levels in whole fish (the Androscoggin River - maximum 29 ppt, and the Rainy River - maximum 85 ppt) had upstream pulp and paper mill discharges. Further investigations at those sites included sampling of waste treatment sludges from the mills. Although the analyses are not complete, 2,3,7,8-TCDD was found in sludge



* SITES FOR WHICH BOTH WHOLE FISH AND FILET DATA WERE AVAILABLE. PROTOCOL SPECIFIED ANALYZING FILET SAMPLES ONLY WHEN 2,3,7,8-TCDD WAS DETECTED IN THE WHOLE FISH SAMPLES.

FIGURE 4-6. COMPARISON OF 2,3,7,8-TCDD IN WHOLE FISH AND FILETS AT BACKGROUND SITES

TABLE 4-7
SUMMARY OF INDUSTRIAL DISCHARGES AT TIER 7 FISH SITES

	Number of Sites[a]					
	Statistical		Regional		All	
Industry*	Detected	Not Detected	Detected	Not Detected	Detected	Not Detected
No Industry	2	22	28	28	30	50
Any Industry	15	51	69	126	84	177
Pulp & Paper	7	6	27	24	34	30
Steam Electric	8	14	36	40	44	54
Organic Chemicals	3	5	27	15	30	20
Inorganic Chemicals	3	7	19	10	22	17
Superfund Sites	2	3	17	18	19	21
POTWs	13	44	65	108	78	152
Metal Discharging	6	21	46	60	52	81
Other Industrial	8	14	36	36	44	50
Misc. Industries	11	32	53	71	64	103

[a] Numbers reported for industrial categories are not mutually exclusive; summary excludes Great Lakes, estuarines, and coastal sites.

Total Number of Statistical Sites = 90	Total Number of Regional Sites = 223
Detected = 17	Detected = 69
Not Detected = 73	Not Detected = 154

*The industrial categories include the facilities in the following SIC codes:

- Pulp and Paper - SIC 2611, 2621, 2631, 2641, 2642, 2643, 2645, 2646, 2647, 2648, 2649, 2651, 2652, 2653, 2654, 2655, and 2661
- Steam Electric - SIC 4911 and 4931
- Organic Chemicals, Plastics, and Synthetic Fibers and Pesticides Manufacturers SIC 2821, 2823, 2824, 2865, and 2869.
- Inorganic Chemicals and Pesticides Manufacturers - SIC 2812, 2813, 2816, and 2819
- Superfund Sites - SIC 8999.
- POTWs - SIC 4952 and 4954
- Metal Discharging Industry - Includes all facilities identified in the following industrial categories: Aluminum Forming, Battery Manufacturing, Coal Mining, Coil Coating, Foundries, Iron & Steel, Metal Finishing, Nonferrous Metals, Ore Mining, Paint, Porcelain Enameling, Copper Forming, Ink, Auto and Other Laundries, Photographics, and Electrical Components
- Other Industrial Categories - Includes all facilities identified in the following industrial categories: Leather Tanning, Textiles, Timber, Pharmaceuticals, Petroleum Refining, Misc. Chemicals, Argicultural Chemicals, Misc. Petroleum Products.
- Miscellaneous Industries - Includes all the remaining industrial categories, such as Food Products, Lumber, Real Estate.

samples, with levels of up to 414 ppt in samples from mills using a chlorine bleaching process. Additional investigations, including those previously described for the Petenwell Flowage Tier 5 site, are underway by the EPA, the states, and the paper industry to determine the sources of 2,3,7,8-TCDD within several mills that produce bleached pulp using chlorine-based chemicals.

4.4.4 Findings

- 2,3,7,8-TCDD was detected infrequently and at very low levels in background soil samples. Seventeen of the 221 urban sites and 1 of 138 rural sites had detectable levels, with the highest level found being 11.2 ppt in an urban soil sample.
- 2,3,7,8-TCDD was detected more frequently in background fish samples than in background soil samples. The EPA estimates that 21 percent of the sites in the U.S. Geological Survey national monitoring networks would have detectable levels of 2,3,7,8-TCDD in fish. The frequency of detection is greater (31 percent) at sites selected by the EPA's regional offices, many of which are near industrial and urban areas.
- An even higher proportion (23 of 29) of Great Lakes fish sampling sites had detectable levels of 2,3,7,8-TCDD. This is consistent with previous findings and is not surprising since the long water retention times in the Great Lakes tend to increase the potential for bioaccumulation and there are many sources of pollutants entering the lakes.

4.4.5 Conclusions

- Levels of 2,3,7,8-TCDD found in filet samples may be a cause for concern at specific locations under certain consumption patterns; local exposure conditions need to be evaluated in determining a level of concern for those areas.
- Fish and shellfish from estuarine and coastal waters were rarely contaminated; three of the four contaminated sites were in areas heavily influenced by industrial discharges.
- A previously unsuspected source of contamination in some areas appears to be certain types of pulp and paper mill discharges; mills using a chlorine bleaching process are being investigated by the EPA, the states, and the paper industry to determine the source of 2,3,7,8-TCDD within the mills.

- Since recent studies (EPA, 1985c; Mehrle, 1986) indicate that 2,3,7,8-TCDD has a half-life of less than one year in fish, fish contamination is a current and continuing phenomenon.

5.0 QUALITY ASSURANCE/QUALITY CONTROL

5.1 Introduction

The overall objective of the Quality Assurance/Quality Control (QA/QC) program was to ensure that the quality of the data would be sufficient to meet the goals of the National Dioxin Study. To achieve the overall QA/QC objective, general requirements for data comparability, data representativeness, and data completeness were established. In addition, specific data quality objectives (DQOs) for the analytical data were defined (e.g., precision, bias, minimum levels of detection, and isomer specificity).

The requirement for comparability was particularly significant, since sampling and analytical activities were conducted throughout the nation by a number of different organizations. Sampling was performed by EPA personnel, state personnel, and contractors; analyses were performed in 13 contract laboratories (CLP), three EPA laboratories, and one additional laboratory used to supplement the EPA capacity; and the data were reviewed and validated by the EPA laboratories and the EPA regional offices.

The QA/QC task was further complicated by the number of analytical procedures that were required, since they involved different limits of detection and different sample matrices. For example, sample types collected for 2,3,7,8-TCDD analysis included, but were not limited to, soil, sediment, water, air, fish, and other biological specimens. The 13 CLP laboratories performed soil/sediment/dust analyses for Tiers 3 and 6 samples at a detection limit of approximately 1 ppb. The Troika laboratories analyzed samples from Tiers 5 and 7, as well as any non-soil/sediment samples from Tiers 3 and 6 at a detection limit of approximately 1 ppt. Water samples were analyzed at a detection limit of approximately 1 to 10 ppq.

The overall project control and flow of information were described in Section 3.0. This section addresses the quality assurance approach, the specific QA/QC data objectives, the controls established to ensure achievement of those objectives, and the results of the data assessment. Brief summaries of the relevant guidance documents and reports are included, where appropriate, to illustrate the technical controls and guidance applied to this study.

5.2 Overall Approach to Quality Assurance

5.2.1 Background

A comprehensive QA/QC program was established for the National Dioxin Study. In order to oversee this program, a Quality Assurance Task Group (QATG) was formed, which consisted of the OWRS QA Officer and representatives from the EPA Regions II, V, and VII. These three regions were included because of their extensive experience with dioxin sampling and analysis. The QATG provided overall QA/QC guidance and established the data assessment and validation procedures. The QATG also ensured, through field and laboratory audits, that the established QA/QC procedures were followed and that any necessary corrective action was implemented.

The QA/QC effort under the National Dioxin Study included the development and implementation of a series of guidance documents, procedures, and management controls directed at ensuring effective project control and final data utility. These are discussed briefly below.

5.2.2 Guidance Documents

Overall Project

A controlled approach to the National Dioxin Study was established from the start by the development of the Dioxin Strategy (EPA, 1983a), as discussed in Section 3.0.

The Quality Assurance Project Plan for Tiers 3, 5, 6, and 7 of the National Dioxin Study (EPA, 1984b) was prepared to provide overall QA/QC guidance for the study. This document set forth the basic objectives of the study, described the methodology to be used to achieve the study objectives, and identified the important elements of field and laboratory QA/QC that had to be met. The QA plan proposed a uniform approach to fulfilling those objectives so that a valid basis for a national dioxin assessment could be established.

Field Sampling

The need for sampling guidelines was recognized as crucial if the study objectives of data comparability, data completeness, and data representativeness were to be achieved. A method for selecting sampling sites within the various tiers was developed, and procedures were established for selecting sampling points within a specific site.

The Sampling Guidance Manual for the National Dioxin Study (EPA, 1984c) provided standard operating procedures for collecting representative, comparable, and consistent dioxin samples in all media on a national level. This document addressed sample control, sample handling, sample preservation, sample shipment, and safety considerations. Major emphasis was focussed on procedures for collecting soil, fish, shellfish, and sediment samples. Recommendations for sampling ambient water, groundwater, and terrestrial specimens were also included.

Analysis

The National Dioxin Study followed the stringent measures used by the EPA since 1975 to validate quantitative measurements of 2,3,7,8-TCDD obtained by different laboratories. The basic validation principles include: 1) demonstration and validation of methods in participating laboratories; 2) analysis of blind and identified QA samples during analysis of field samples; and 3) use of defined analytical criteria for confirmation of 2,3,7,8-TCDD detection.

The Troika analytical and QA procedures are detailed in the Analytical Procedures and Quality Assurance Plan for the Analysis of 2,3,7,8-TCDD in Tiers 3-7 Samples of the U.S. Environmental Protection Agency National Dioxin Study (EPA, 1984d). These procedures were designed to be used for most of the samples received by the Troika. It was acknowledged, however, that "troublesome" samples might necessitate modification, or additional method development, to provide valid analytical data.

Thirteen CLP laboratories, which had previously demonstrated and validated their analytical capabilities in the EPA EMSL-LV certification program, used the detailed methodology developed for the Superfund Program to perform 2,3,7,8-TCDD analyses. The methodology requires strict adherence to chain-of-custody protocol, document control, state-of-the-art GC/MS/DS instrumentation, and quality assurance procedures. The analytical procedures and the QA/QC requirements were specified in detail. Criteria used for confirming or negating the presence of 2,3,7,8-TCDD, and methods for calculating its concentration or estimating the minimum detectable amount, are provided (EPA, 1984e); strict acceptance criteria for field samples and quality control samples are also given.

Data Validation

Review and validation of all CLP data for the National Dioxin Study were performed by EPA regional personnel. The QATG provided guidance on data assessment and validation (EPA, 1985b) to ensure that the independent data reviews by each regional office utilized uniform data acceptance, rejection, or qualification criteria. Validation of the Troika results was performed within the EPA laboratories.

5.2.3 Controls

Several review steps were established to determine whether the developed guidelines had been appropriately implemented. These steps are briefly summarized below.

Regional Plans

Each EPA regional office prepared an overall implementation plan, addressing the arrangements for sampling in each tier, a tentative schedule for sampling, and a Tier 7 sampling plan. Subsequently, the regional offices prepared site-specific work plans for each Tier 3, 5, or 6 site, as described in Section 3.0. Once detailed sampling plans had been reviewed to ensure that sample collection procedures conformed to the guidance manuals, the regional offices initiated field sampling.

Audits

Identifying, correcting, and documenting quality control problems are among the most crucial aspects of a quality assurance plan. In accordance with the QA Project Plan for the National Dioxin Study (EPA, 1984b), the EPA regional offices performed periodic field audits with guidance from the QATG. During the audits, sampling activities were observed and checked for consistency with the recommendations in the project plan (EPA, 1984b), the sampling guidance manual (EPA, 1984c), and the site-specific work plans. Where necessary, changes or corrections in the sampling procedures were made. Reports documenting the findings of the field audits were submitted to the QATG.

The QA plan also addressed on-site laboratory audits. Audit teams consisting of at least one member of the QATG, two or three additional EPA personnel designated by the QATG, and a representative from EMSL-LV performed audits of the Troika laboratories. In addition, an external audit team performed an overall management systems audit of the Troika analytical program. Conformance with analytical methodologies and QA guidance, as well as any other recommendations of the audit team, was documented in the audit reports.*

As part of the Contract Laboratory Program, EMSL-LV developed and implemented a certification and audit program (EPA, 1984e; EPA, 1984f). All CLP laboratories utilized in the National Dioxin Study had been certified by this program. No additional laboratory audits were conducted by the QATG.

Performance audits, consisting of the analysis of performance evaluation (CLP) and reference (Troika) samples, were incorporated into the analytical programs. The results of these analyses were required to fall within acceptable limits for each set of samples before the sample data could be considered valid.

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*Reports on both the laboratory and field audits were prepared and submitted to the QATG; these are available from the QA officer at the OWRS.

The audit teams reported any deficiency or unacceptable performance detected during any of the audits to the QATG and immediately notified the responsible party of their findings and of the deadline for implementing corrective action.

Validation

All laboratory analytical data were validated before they were considered final. The Troika data were reviewed and validated internally.

The CLP data were validated according to standard procedures established by the QATG (EPA, 1985b), and utilized by the EPA regional offices responsible for the specific sites. The purpose of the review was:

1. to assure the validity of data reported by the laboratory;

2. to assure that the laboratory followed appropriate quality control measures as stated in the method; and

3. to assure that the data were displayed in an acceptable manner, i.e., to allow quick review and transmittal to the data user.

The data review resulted in a classification of each sample as either valid or invalid. Data quality discrepancies were resolved by the regional reviewers, the QATG, and the reporting laboratory. The criteria used to evaluate data were based on examination of:

- Data Completeness
- Instrument Performance
- Calibration Review
- Qualitative Review
- Quantitative Review
- Surrogate Spikes
- Internal Standards
- Laboratory Reagent Blanks
- Fortified Field Blanks
- Duplicates (field and laboratory)
- Performance Evaluation Samples
- Rinsate Samples

The data obtained for each site were reviewed by the respective regions and will be incorporated into site-specific final reports. The final reports summarize available information on the site, analytical results, and regional recommendations on follow-up activities.

5.3 Data Quality Objectives

The data quality objectives for the National Dioxin Study were both qualitative and quantitative. The objectives of data comparability and data representativeness are generally qualitative in nature. Their achievement is ensured by adherence to sampling, analysis, and QA plans and by fulfilling more quantitative objectives, such as data completeness, precision and bias requirements, and minimum detection limits. Both types of objectives and their means of implementation are discussed below.

5.3.1 Comparability

Data comparability is defined as the extent to which the sample results can be duplicated by another independent laboratory or compared against previous results. This objective was extremely important to the success of the National Dioxin Study, since samples collected by various sampling teams were analyzed in up to 13 CLP laboratories and 3 EPA laboratories.

The measures taken to ensure data comparability, as outlined in the QA Project Plan (1984b), are summarized below:

- Uniform supply of sampling containers;
- Standard handling and shipping procedures;
- Written standard operating procedures for sampling and analysis activities;
- Standardized forms for recording field data and analytical data, prepared sample identification tags, and chain-of-custody records;
- Certified standard solutions of 2,3,7,8-TCDD; (1) CLP laboratories received solutions provided by EMSL-LV for preparation of all calibration standards, and (2) Troika laboratories used primary analytical standards referenced to the EMSL-LV standard or other verified standards;
- Regular distribution of performance evaluation samples for analysis; and
- Regular analysis of replicates and reference samples to enable evaluation of intra- and inter-laboratory precision.

The results obtained for the performance evaluation samples and the inter-laboratory duplicate analyses were the primary direct means of verifying data comparability. The Troika QC data also provided a means of evaluating method performance and the comparability of the methods used for the various sample matrices.

Analytical data for each sample set were reviewed and validated according to established data review procedures (EPA, 1984d; EPA, 1985b). The primary components of the data review included:

- Verification of isomer specificity;
- Check of qualitative criteria (isotope ratios and retention times) for all positive identifications;
- Verification that field blanks and method blanks were free of 2,3,7,8-TCDD contamination above an established level;
- Check of acceptability for performance evaluation samples of known 2,3,7,8-TCDD concentration;
- Check of acceptability for matrix spike samples of reference samples;
- Check of acceptability for recovery of labeled TCDD spiked into samples prior to extraction;
- Check of laboratory duplicate analyses; and
- Verification of achievability of minimum detection limit.

5.3.2 Data Representativeness

Data representativeness can be defined as the extent to which the data set is demonstrably unbiased or within established bias limits. Criteria for data representativeness, i.e., acceptable sampling variances, are set such that the data will meet the objectives of the study.

In the case of the National Dioxin Study, a methodical approach to selecting sampling sites was developed so that the samples collected would be as representative as possible of the designated tiers. In addition, detailed sample collection procedures were developed in the sampling plan (EPA, 1984c). These included, for example, use of tulip planters to collect soil samples of a uniform depth, use of core liners for most sediment samples, and identification of target species to comprise the fish samples. The representativeness of the sampling procedures was evaluated by the blind-coded analyses of field duplicates. The representativeness of the measured concentrations was also evaluated by calculating the analytical bias based on analysis of samples spiked with known concentrations of 2,3,7,8-TCDD.

5.3.3 Data Completeness

Completeness was defined as the percentage of valid data (i.e., that which meets all QA requirements) compared to the total number of samples analyzed. The National Dioxin Study established a target for data completeness of 80 percent for Tiers 3, 5, 6, and 7 (EPA, 1984b). The Troika QA plan (EPA, 1984d) sets a target of 100 percent for data completeness, since only data that have been reviewed and have met all requirements to assure their validity were expected to be included in the data system. A computerized sample tracking/status system was used to monitor data completeness and progress of the program.

5.3.4 Quantitative Analytical Objectives

The quantitative objectives for the analytical data are generally expressed in terms of precision, bias, and detection limit; other analytical issues include isomer specificity, calibration, and false positives. Based on CDC action levels and the best available analytical methodologies, objectives were established for analytical precision, bias, and detection limits (Table 5-1).

The precision of the analyses was estimated by evaluating laboratory and field duplicate sets for each of the CLP and Troika laboratories. The performance evaluation samples, analyzed repeatedly by the CLP laboratories, provided an additional measure of precision. This was particularly important since most of the field samples and duplicate pairs were found to be below the target detection limit. Bias measurements were based on the accuracy of matrix spike samples (CLP and Troika) and surrogate accuracy (CLP).

Daily column performance checks and strict identification criteria with respect to retention time and mass ion ratios were established to ensure isomer specificity. Similarly, initial and daily calibration criteria were specified to ensure correct calculation of 2,3,7,8-TCDD concentration levels.

Blanks were analyzed to control the possibility of false positives. Demonstration of the minimum detection limit for each sample in which 2,3,7,8-TCDD was not detected was also required to control for false negatives.

The implementation of these qualitative or analytical objectives, verified by the data review process, provided direct assurance that the data comparability and data completeness objectives would be met. The entire QA plan assured that the data collected for the National Dioxin Study would be of sufficiently high quality to meet the study objectives.

5.4 Estimates of Data Quality

The data quality objectives that lend themselves to quantification are summarized below. Each was based on one or more of the requirements of the QA/QC program. The procedures outlined in Sections 5.3.3 and 5.4.3 of Calculation of Precision, Bias and Method Detection Limit for Chemical and Physical Measurements (EPA, 1984g) were used for guidance.

TABLE 5-1

QUANTITATIVE OBJECTIVES FOR 2,3,7,8-TCDD ANALYSES

	Target Detection Limit	Precision[a]	Bias[b]
CLP	1 ppb	≤ 25%	± 25%
Troika			
Soil/sediment/ biological tissue	1 ppt	≤ 50%	± 50%
Water	10-40 ppq	≤ 50%	± 50%

[a] Expressed as relative standard deviation (RSD) of duplicate or replicate measurements.

[b] Expressed as the percent variation of the actual recovery compared to 100 percent of the 2,3,7,8-TCDD added into laboratory-spiked matrices.

5.4.1 Precision

Approach

Measurements of the precision of the National Dioxin Study data included data for field duplicates, laboratory duplicates, and performance evaluation (CLP) or reference (Troika) samples. The performance evaluation or reference samples were particularly important because a large percentage of the National Dioxin Study duplicate analyses were below the limit of detection. All the valid data compiled for each analytical laboratory were used to make precision estimates for that laboratory.

The duplicate data provide a measure of the intra-laboratory precision achieved in the analysis of National Dioxin Study samples. The mean concentration ($\overline{X}$), standard deviation (s), and relative standard deviation (RSD) were determined for each duplicate pair having both measurements above the detection limit. In the case of Troika duplicate pairs in which one sample was positive and one sample was not detected (ND), the detection limit was used as an estimate of the concentration of the not detected sample. The values for each matrix type were evaluated to determine the relationship between precision and concentration. A summary precision value, pooled standard deviation (S_p), was calculated for the reported concentration range or smaller concentration ranges within the reported range. An overall RSD was also calculated by using the mean concentration of all data points within the data set.

The performance evaluation (PE) and reference samples provide a measure of inter-laboratory precision to the extent that they were analyzed in different laboratories. For the CLP data, the PE samples were generally analyzed repeatedly in different laboratories and provide a measure of inter-laboratory and intra-laboratory precision. For the Troika data, the fish reference samples were analyzed exclusively at ERL-Duluth and provided only intra-laboratory precision; the sediment and soil reference samples were analyzed in different laboratories and did provide a measure of inter-laboratory precision.

In using the performance evaluation (PE) and reference samples as a measure of precision, all measurements corresponding to a single PE concentration or single reference sample were treated as replicate measurements and used to generate a mean concentration ($\overline{X}$), standard deviation (s), and relative standard deviation (RSD). If more than one PE concentration was used, the relationship of s vs. $\overline{X}$ or RSD vs. $\overline{X}$ was assessed and the summary precision estimates were reported.

For each matrix type, a summary estimate, i.e., a pooled standard deviation (S_p), was calculated from the data obtained for the different reference/PE samples within the matrix type. The formula used to calculate the pooled standard deviation for the reference samples considers the number of analyses of each reference sample as well as the standard deviation for the set of analyses. These statistics were computed for the concentration range of PE/reference samples or a narrower concentration range within the overall range if appropriate. An overall RSD was also calculated by using the mean concentration of all data points within the selected concentration range.

Results

Table 5-2 summarizes precision estimates available for the CLP laboratories and the Troika laboratories. The CLP precision results are presented as the mean relative standard deviations calculated from the pooled standard deviations, where appropriate. There was one field duplicate pair and eight laboratory duplicate pairs for which positive 2,3,7,8-TCDD values were obtained for both samples. (Four of the positive laboratory duplicate pairs were actually PE samples analyzed in duplicate.) All results fell within the precision targets.

The Troika precision, based on duplicate data, was also reported as the mean relative standard deviation calculated from pooled standard deviations, where appropriate. Results were presented for each matrix. There were 34 fish laboratory duplicate pairs for which positive 2,3,7,8-TCDD values were obtained; 20 soil pairs, 14 sediment pairs, and one water pair met the same criteria. Troika field duplicate pairs with positive results included 19 soil pairs, 5 sediment pairs, and 1 water pair. For most of the individual duplicate pairs, the RSD was within the 50 percent precision target set for the Troika analyses. Exceptions included three duplicate pairs (one sediment and two soil pairs) where the RSDs ranged from 60 to 102 percent and four laboratory duplicate pairs (one sediment, one fish, and two soil pairs) where the RSDs ranged from 60 to 84 percent.

The reference sample data for fish and soil reflect the fact that three reference fish samples and various reference soil concentrations were analyzed. Pooled standard deviations and relative standard deviations were calculated as discussed previously. None of these precision summaries exceeded the targets presented in Table 5-1.

Additional information on precision estimates, and duplicate and replicate analyses are available in a detailed report to the OWRS QA officer.

TABLE 5-2

SUMMARY OF PRECISION STATISTICS

MATRIX		n	RSD
CLP			
Soil			
Laboratory Duplicates	(0.4-7.9 ppb)	8 pr.	7%[a]
Field Duplicates	(0.4 ppb)	1 pr.	7%[b]
PE Samples	(0.84-7.9 ppb)	c	16%[a]
Troika			
Fish			
Laboratory Duplicates	(0.4-18 ppt)	33 pr.	12%[a]
	(36 ppt)	1 pr.	14%[b]
Reference Samples	(14-35 ppt)	d	16%[a]
Soil			
Laboratory Duplicates	(0.3-7 ppt)	17 pr.	26%[a]
	(16-42 ppt)	3 pr.	7%[a]
Field Duplicates	(0.4-3 ppt)	9 pr.	36%[a]
	(6-35 ppt)	7 pr.	25%[a]
	(77-2600 ppt)	3 pr.	22%[a]
Reference Samples	(5-50 ppt)	e	16%[a]
Sediment			
Laboratory Duplicates	(1-5 ppt)	11 pr.	29%[a]
	(11-38 ppt)	3 pr.	35%[a]
Field Duplicates	(0.6-65 ppt)	5 pr.	13%[a]
Water			
Laboratory Duplicate	(0.4 ppt)	1 pr.	0%[b]
Field Duplicate	(0.1 ppt)	1 pr.	7%[b]

[a] Calculated from pooled standard deviation (Sp), as discussed in text.
[b] RSD of single duplicate pair or one reference sample.
[c] 122 analyses of 8 PE samples.
[d] 103 analyses of 3 reference fish.
[e] 42 analyses of contaminated soil at 8 concentrations.

Data as of May 1986

5.4.2 Bias

Approach

The bias of the laboratory measurements was determined on the basis of 1) recovery of surrogates spiked into each sample prior to extraction (CLP), and 2) recovery of unlabeled 2,3,7,8-TCDD spiked into blank matrices (CLP and Troika). The percent bias, reported as the positive or negative variation from 100 percent of the true value, was calculated according to the following formula: % Bias = $\bar{P}$-100, where $\bar{P}$ is the mean percent recovery. Bias estimates were generated for each laboratory program (CLP/Troika) and each matrix was analyzed within the Troika program.

Based on the surrogate recovery data, $\bar{P}$ was computed as the mean percent recovery of the surrogate using all valid data reported during the specified time period. With the fortified blank matrix data, $\bar{P}$ was computed as a mean percentage recovery of 2,3,7,8-TCDD spiked into the blank samples.

Results

Table 5-3 summarizes the bias estimates for the CLP laboratories and the matrices analyzed in the Troika laboratories. The CLP data are presented as an average bias calculated for all CLP samples. The estimates in Table 5-3 do not exceed the target of ±25 percent presented in Table 5-1. Additional information is available in the detailed report to the OWRS QA officer.

The Troika data are presented as the average bias estimates and range of bias values calculated for individual matrices. Two of the fish spikes fell outside the target bias limits of ±50 percent; the two bias values were +80 and +82 percent. All other fish recoveries fell within the range of +18 to +46 percent bias. One soil spike also exhibited a bias outside of the acceptable range, i.e., -76 percent bias; all other soil spikes fell within the range of -25% to +33 percent bias. The single egg spike and one of the two vegetation spikes exhibited bias values of +72 percent and +60 percent, respectively; these also fell outside of the ±50 percent target for bias.

5.4.3 Completeness

Data completeness was calculated as the percentage of analyzed samples having valid data, i.e., fulfilling all QA/QC requirements. All Troika data met established validation criteria. There were several samples for which the detection limits were higher than the proposed target detection limit. The Troika data base is approximately 97 percent complete, since there are some samples for which valid analyses have not been obtained.

TABLE 5-3

SUMMARY OF BIAS[a] STATISTICS

CLP

	n	Avg. Bias	SD
Fortified Field Blank - Soil	117	-2.3%	12.2
Surrogate:			
Soil	2243	+1.8%	11.8
Dust	32	+2.3%	11.7
Sediment	32	-5.7%	11.7

Troika

Fortified Matrix:	n	Avg. Bias	Range
Fish	6	+49%	+18% to +82%
Mollusk	2	-8%	-15% to 0%
Soil	118	+0.5%	-76% to +33%
Sediment	8	-6%	-32% to +5%
Water	7	+19%	-30% to +44%
Vegetation	2	+28%	- 3% to 60%

[a] Reported as % Bias = $\overline{P}$-100, where $\overline{P}$ is mean percent recovery.

Data as of May 1986

Ninety-two percent of the CLP data met all QA/QC requirements; 91 percent of the Tier 3 CLP data and 97 percent of the Tier 6 data were considered valid.

5.4.4 False Positives

The issue of false positives was evaluated by reviewing the data for the blank samples analyzed with the field samples. For the CLP data, only one field blank sample was reported to be contaminated at a level greater than 0.05 ppb (0.39 ppb). There were no positive field samples associated with this field blank. In addition, one contaminated reagent blank (0.07 ppb) was reported; no contaminated rinsates have been reported in the CLP data received to date.

Two positive soil matrix blanks (2.0 and 0.3 ppt) were reported in the Troika data base; a total of 80 soil matrix blanks were analyzed. None of the 63 matrix blanks for other media were found to be contaminated. No contaminated field blanks or method blanks were reported; there were 63 field blanks and 151 method blanks analyzed.

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APPENDIX A. HEALTH ASSESSMENTS FOR TCDD

A.1 Introduction

The detection of 2,3,7,8-TCDD in various environmental media has prompted several federal agencies to develop guidelines or criteria for levels of concern in water, soils, and fish. For example, the Environmental Protection Agency (EPA) has established a Water Quality Criteria for 2,3,7,8-TCDD; the Centers for Disease Control (CDC) has recommended levels of concern for soil contaminated with 2,3,7,8-TCDD, and the Food and Drug Administration (FDA) has developed levels of concern for 2,3,7,8-TCDD in fish in the Great Lakes. These recommended levels or criteria, summarized in Table A-1, can be useful to evaluate the results of the National Dioxin Study. However, they were developed for different purposes based on different assumptions, and sometimes for specific locations. The purpose of this appendix is to discuss those assumptions and to provide a basis for using the assessments under different conditions. The following sections address the purposes of the recommendations and the related exposure and toxicity assumptions made for each.

This appendix provides a discussion of several specific health assessments for exposure to 2,3,7,8-TCDD which can be useful in interpreting the data from the National Dioxin Study. It should be noted that there are other methodologies for estimating exposure and cancer risks associated with 2,3,7,8-TCDD exposure using various approaches, assumptions, and evaluations (e.g., Schaum, 1984; Kreiger, 1985).

A.2 Purposes of the Three Health Assessments

A.2.1 Water Quality Criteria for 2,3,7,8-TCDD (U.S. EPA 1984a)

Section 304(a)(i) of the Clean Water Act of 1977 (P.L. 95-217) requires the Administrator of the Environmental Protection Agency to publish criteria for the protection of water quality. The water quality criteria represent non-regulatory scientific assessments of effects on aquatic life and human health and are intended to assist the states in developing water quality standards. In developing their water quality standards, the states may choose to consider local environmental conditions and exposure patterns.

A.2.2 Level of Concern in Residential Soil (CDC-Kimbrough et al., 1984)

As a result of several contamination incidents in Missouri, the CDC was asked to provide a level of 2,3,7,8-TCDD in soil that represented an unacceptable health risk to the population living

TABLE A-1
RECOMMENDED LEVELS OR CRITERIA FOR 2,3,7,8-TCDD

Recommending Agency	Type of Recommendation	Level
EPA	Ambient Water Quality Criteria for the Protection of Human Health:	
	- ingestion of water and aquatic organisms	1.3×10^{-9} - 1.3×10^{-7} ug/L[a]
	- ingestion of aquatic organisms only	1.4×10^{-9} - 1.4×10^{-7} ug/L[a]
	- ingestion of water only	2.2×10^{-8} - 2.2×10^{-6} ug/L[a]
FDA	Advisory to the Governor of Michigan regarding concentrations of concern in fish in the Great Lakes	25 ppt - little cause for concern 25-50 ppt - sport fishermen limit consumption of fish from these areas to no more than one meal/week. Permanent residents limit consumption to no more than 1-2 meals/month >50 ppt - states should consider limiting fishing in these areas
CDC	Soil level of concern:	
	- Residential areas	1 ppb
	- Grazing areas	6-20 ppt

[a] For an increased lifetime cancer risk ranging from 10^{-7} to 10^{-5}

in the contaminated area. In response, the CDC considered the health effects associated with 2,3,7,8-TCDD and the relevant exposure patterns for soil contamination, particularly exposure patterns for children. The resulting recommended level of concern of 1 ppb in residential soil applied initially to the specific exposure occurring in Missouri. However, Kimbrough et al. (1984) suggest that it applies to all residential soils, since the exposure patterns are not particularly site-specific. Additionally, the level of concern for soil concentrations can be more or less than 1 ppb, depending on land use.

For grazing areas, 2,3,7,8-TCDD levels in soil that are projected to produce the maximum allowable residue levels in foods are: 6.2 ppt for milk; 12 ppt for pork; and 20 ppt for beef. In certain industrial settings, levels well above 1 ppb may be acceptable. Kimbrough et al. (1984) suggest that these values should be considered a guide to situations that require a more detailed evaluation.

A.2.3 Level of Concern for 2,3,7,8-TCDD in Fish (FDA, 1981)

A level of concern was developed by the FDA in response to requests from the several states confronted with the discovery of dioxin contamination in fish in the Great Lakes. The level of concern is based on observed contamination in specific species and on exposure patterns for the Great Lakes. Levels of contamination and the species found, as well as fish consumption patterns, would generally be different in other areas of the country.

The FDA determined that concentrations of up to 25 ppt in the edible portion of fish did not pose an unacceptable risk to the public health in that area. For concentrations between 25 and 50 ppt, the FDA recommended limiting consumption; for concentrations above 50 ppt, the FDA recommended a ban on consumption. The FDA also concluded that these recommendations would have only a minimal impact on the availability of Great Lakes fish as a food source.

A.3 Exposure Considerations

Varying assumptions were made for exposure pathways and patterns in the three Agency assessments. These assumptions are summarized in Table A-2 and are discussed below.

A.3.1 Water Quality Criteria (U.S. EPA, 1984a)

The EPA water quality criteria for the protection of human health are all based on an average consumption of 2 liters per day of water and/or 6.5 grams per day of fish and shellfish over a 70-year lifetime. All water quality criteria also assume that 100 percent of the fish consumed is contaminated. For 2,3,7,8-

TABLE A-2

MAJOR EXPOSURE ASSUMPTIONS FOR THE RECOMMENDED LEVELS

Recommendations	Exposure Assumptions
EPA Water Quality Criteria for Surface Water	° Consumption of 2 L/day drinking water and/or 6.5 g/day fish, shellfish, over a 70 year lifetime, 100% from water body of interest
	° Weighted average bioconcentration factor of 5000 based on weighted average 3% lipid in typical fish/shellfish seafood diet
	° Bioconcentration factor applied to all fish in diet (100% contaminated)
	° All fish consumed contaminated equally
	° Absorption in GI tract - 100%
	° Human body weight - 70 kg
	° Criteria presented for an increased lifetime risk of cancer of 10^{-7} - 10^{-5}
FDA Level of Concern for Fish	° Fish consumption of 15.70 g/day over a 70 year lifetime, 10% of which would be contaminated bottom feeders from the area.
	° Absorption in the GI tract - 100%
	° Average fish concentration levels would be approximately 1/3 of advisory levels (25 ppt).
	° Human body weight - 70 kg.
	° An increased lifetime risk of cancer of about 3×10^{-6} would result with a 25 ppt maximum residue level.

TABLE A-2 (Cont'd)

MAJOR EXPOSURE ASSUMPTIONS FOR THE RECOMMENDED LEVELS

Recommendations	Exposure Assumptions
CDC Level of Concern for Residential Soil	
General Assumptions	• TCDD has a half-life in soil of 12 yr. • All soil assumed contaminated at same level (100% contamination) • Exposure occurs during 6 months of the year and is averaged over a 70-year lifetime. • Human body weight - 70 kg. • An increased lifetime risk for cancer of approximately 2.5×10^{-5} would result, assuming an initial soil concentration of 1 ppb and the lower bound for the virtually safe dose.
CDC Exposure Pathway Specific Assumptions -	
Ingestion	• Daily soil consumption varied with age: 0-9 months - 0 g 9-18 months - 1 g 1-1/2 - 3-1/2 yrs - 10 g 3-1/2 - 5 yrs - 1 g > 5 yrs - 0.1 g • Absorption in GI tract - 30%
Dermal	• Daily soil contact with skin varied with age: 0-9 months - 0 g 9-18 months - 1 g 1-1/2-3 - 1/2 yrs - 10 g 3-1/2 - 15 yrs - 1 g > 15 yrs - 0.1 g • Absorption through skin - 1%

TABLE A-2 (Cont'd)

MAJOR EXPOSURE ASSUMPTIONS FOR THE RECOMMENDED LEVELS

	Exposure Assumptions
Inhalation	• Concentration of TCDD on airborne dust is equivalent to soil. • 15 m^3 of air exchanged/day • 100% of TCDD inhaled is absorbed

TCDD, a weighted average bioconcentration factor of 5000 was used in developing the criteria. This bioconcentration factor is based upon a 3 percent weighted average percent of lipids for freshwater and estuarine fish and shellfish in the typical diet.

Local factors that should be considered in applications of the EPA water quality criteria are:

- Local patterns of fish consumption;
- Consumption of fish from a contaminated water body relative to that from other locations; and
- Percent lipids in locally consumed species.

Table A-3 presents several exposure scenarios using the EPA cancer model to derive average levels of 2,3,7,8-TCDD in the edible portion of fish with the corresponding lifetime risks. The scenarios and corresponding fish tissue levels are not meant to be used in setting levels of concern, but rather to show average levels of 2,3,7,8-TCDD in filets that could result in various lifetime cancer risks using different assumptions. Site-specific considerations described previously should be evaluated by health departments to determine appropriate levels of concern.

A.3.2 FDA Level of Concern for Fish (FDA, 1981; Miller, 1983)

The FDA assumed a fish consumption level of 15.7 g/day, compared to the 6.5 g/day assumed by the EPA. This value was the 90th percentile freshwater fish consumption in the eight states that border the Great Lakes, and was based upon a survey of consumption patterns. The selected fish that were likely to be contaminated included bottom feeders, which were thought to represent about 10 percent of the freshwater fish consumption. Thus, the FDA's consumption level was designed for fish species consumed in a specific geographic area. In addition, it was based on the 90th percentile consumption value for fish in the Great Lakes area. The consumption value used by the EPA in the water quality criteria, however, represents the mean fish and shellfish consumption for the nation.

Like the EPA, the FDA assumed that all fish consumed come from the contaminated area, although the FDA limited its estimate to the specific species most likely to be contaminated. Those species represent about 10 percent of the diet of freshwater fish in that area. In addition, the FDA assumed that the average level of contamination would be about 1/3 of the 25-ppt level of concern.

Local factors that should be considered in using the FDA levels of concern include:

TABLE A-3

AVERAGE CONCENTRATIONS (PPT) IN EDIBLE PORTION OF FISH CORRESPONDING TO DIFFERENT CANCER RISKS (BASED ON EPA MODEL) FOR VARIOUS CONSUMPTION PATTERNS

Consumption Pattern	Cancer Risk		
	10^{-4}	10^{-5}	10^{-6}
1) 10 years 6.5 grams/day 100% of fish contaminated	48	4.8	0.48
2) 10 years 15.7 grams/day 10% of fish contaminated	200	20	2.0
3) 70 years 6.5 grams/day 100% of fish contaminated	6.9	0.69	0.069
4) 70 years 15.7 grams/day 10% of fish contaminated	29	2.9	0.29

NOTE: The FDA estimated that, to assure that no sample from an area exceeds an established residue level, the average level from that area should probably not exceed 1/3 of that amount. Thus the 25 ppt advisory level assumed an average level of about 8 ppt in the contaminated fish.

- Local patterns of fish consumption;

- Species that are likely to become contaminated and the consumption of these species; and

- Consumption of fish from the contaminated water body relative to that from other locations.

A.3.3 CDC Level of Concern for Soil (Kimbrough *et al.*, 1984)

The level of concern for soil, developed by the CDC, was based on consideration of dermal, ingestion, and inhalation pathways. The general assumptions made for all these pathways were that 2,3,7,8-TCDD has a 12-year half-life in soil, all soil is contaminated at the same concentration, and that exposure occurs over 6 months of the year.

Pathway-specific assumptions include consumption, contact or inhalation rate values, and absorption values. For both ingestion and dermal contact, consumption or contact varied with age. These values were generally based on the CDC's judgment, as data on dirt consumption or contact are limited. Absorption from soil was assumed to be 30 percent in the GI tract, and 1 percent through the skin, based upon available literature. For inhalation, the exposure model does not vary with age, but a lifetime air exchange of 15 m^3/day is assumed. The concentration of 2,3,7,8-TCDD in airborne dust is assumed equivalent to soil; absorption of inhaled 2,3,7,8-TCDD was assumed to be 100 percent.

These estimates were developed for residential soil, and exposure patterns are not expected to vary geographically. However, the time period of exposure (6 mo/yr) may be different in areas of the country with milder climates. The CDC provided some guidance for other soil contamination situations, but in these instances local exposure patterns are important considerations.

The consumption patterns and times of contact were assumed by the CDC based upon their judgment. Revisions to these assumptions would likely be based upon the availability of additional data that would be generally applicable, rather than upon site-specific considerations.

A.4 Toxicity Considerations

The carcinogenicity of 2,3,7,8-TCDD to animals has been established in feeding studies conducted with rodents (U.S. EPA, 1984a; Kimbrough *et al.*, 1984). Based on these findings, The EPA has classified this compound as a probable human carcinogen.

This section describes the differences in the assumptions and approaches used by each agency to estimate the lifetime cancer risk associated with ingestion of 2,3,7,8-TCDD.

A.4.1 Major Assumptions

As described below, minor differences exist in the assumptions used by the CDC, EPA, and FDA to develop lifetime cancer risks. Tables A-4 (EPA), A-5 (FDA), and A-6 (CDC) summarize the toxicological data base on which the recommendations are founded, the mathematical risk model used to extrapolate from high animal doses to low human exposures, and any assumptions that were used to calculate the upper-limit individual lifetime cancer risk for each of the risk analyses.

A.4.2 Analysis of CDC, EPA and FDA Toxicity Considerations

The CDC, EPA, and FDA each used the same mathematical model and response data for female rats reported in the study by Kociba and coworkers (1978) to estimate the upper limits of excess individual lifetime cancer risk associated with ingestion of 2,3,7,8-TCDD. However, the EPA viewed 2,3,7,8-TCDD as being 4 times more potent than did the CDC and 9 times more potent than did the FDA.

The difference in the CDC and EPA potency estimates for 2,3,7,8-TCDD is due to the following factors:

- A dose per unit body weight equivalence factor was used by the CDC to extrapolate the animal dose to humans, in contrast to the EPA's established procedure utilizing body surface area to normalize animal-to-man dose equivalence. This difference amounted to a 5.4-fold lower potency value in the CDC's assessment compared to that generated by the EPA.

- The lack of correction for high early mortality in the animal data by CDC, which produced a 1.7-fold lower estimate than that generated by the EPA.

- An average liver concentration at terminal sacrifice was used by the CDC rather than administered dose. Since the liver concentration showed saturation at the highest administered dose, this adjustment had the effect of halving the dose at the highest tumor response point, resulting in increasing the slope by a factor of 2 over the result from fitting the data to the administered dose (i.e., the EPA approach).

The first two items also represent differences between the EPA and FDA potency estimates. Most of the remaining difference between the two estimates is due to the EPA's use of a histopatho-

TABLE A-4

TOXICITY ASSUMPTIONS - EPA AMBIENT WATER QUALITY CRITERIA

95% Upper-Limit Individual Lifetime Cancer Risk:	1.56×10^{5} (mg/kg/day)$^{-1}$
Risk Model:	Linearized multistage
Toxicological Data Base:	Lifetime feeding study conducted by Kociba *et al*. (1978) with Sprague-Dawley rats. Utilized dose-response data for female rats for all significant tumors based on slide reviews of Kociba and independent pathologist (Dr. R. Squire). Data adjusted to compensate for high early mortality.
Assumptions:	° Laboratory animals are reliable surrogates for humans. ° Humans are as sensitive to the carcinogenic effects of 2,3,7,8-TCDD as the most sensitive animal species. ° There is no threshold level below which adverse health effects may not occur. ° Body surface area is an appropriate normalization factor for animal versus human potency.

Source: U.S. EPA (1984a)

TABLE A-5

TOXICITY ASSUMPTIONS - FDA GUIDELINE TO LIMIT HUMAN EXPOSURE TO CONTAMINATED FISH

95% Upper-Limit Individual Lifetime Cancer Risk:	1.75×10^{4} $(mg/kg/day)^{-1}$
Risk Model:	Linearized multistage
Toxicological Data Base:	Lifetime feeding study conducted by Kociba _et al_. (1978) with Sprague-Dawley rats. Utilized dose-response data for liver tumors in female rats and Kociba's histopathological diagnosis. No adjustment for early mortality.
Assumptions:	° Laboratory animals are reliable surrogates for humans. ° Humans are as sensitive to the carcinogenic effects of 2,3,7,8-TCDD as the most sensitive animal species. ° There is no threshold level below which adverse health effects may not occur. ° Body weight is an appropriate normalization factor for animal versus human potency.

Source: FDA (1981), Miller (1983)

TABLE A-6

TOXICITY ASSUMPTIONS -
CDC LEVEL OF CONCERN - RESIDENTIAL SOIL

95% Upper-Limit Individual Lifetime Cancer Risk:	3.6×10^4 (mg/kg/day)$^{-1}$ (when reconverted to administered dose - See Kimbrough *et al*. 1984)
Risk Model:	Linearized multistage
Toxicological Data Base:	Lifetime feeding study conducted by Kociba *et al*. (1978) with Sprague-Dawley rats. Utilized liver concentration-liver tumor response data for female rats. Effective dose rather than administered dose (i.e., liver concentration at administered dose) and slide reviews of independent pathologists (Dr. R. Squire and Kociba). No adjustment for early mortality.
Assumptions:	◦ Laboratory animals are reliable surrogates for humans. ◦ Humans are as sensitive to the carcinogenic effects of 2,3,7,8-TCDD as the most sensitive animal species. ◦ There is no threshold level below which adverse health effects may not occur. ◦ Body weight is an appropriate normalization factor for animal versus human potency.

Source: Kimbrough *et al*. (1984)

logical review by an independent pathologist (Dr. R. Squire) as well as the original Kociba data. FDA used only Kociba's results.

In recent conferences (EPA, 1984b) among the three agencies, the CDC and FDA agreed that it was appropriate for the EPA to adjust tumor response data for early mortality, although no adjustments have been made to the CDC's or FDA's recommended levels. Thus, the 2,3,7,8-TCDD potency value estimated by the EPA, when compared to the potency values of the CDC and FDA corrected for early mortality, is now 2.7 times higher than the CDC; and 5.4 times higher than the FDA's. These remaining differences are primarily attributed to the EPA's use of body surface area as opposed to body weight to normalize animal-to-human dose equivalence.

A.5 Summary

This review of the three health assessments for 2,3,7,8-TCDD reflects the major differences in the assumptions made regarding both exposure and toxicity. The exposure assumptions made are not strictly comparable because they consider exposure by different pathways. In addition, the assessments were intended for different applications. Both the EPA water quality criteria and the FDA level of concern can be used in evaluating results from the National Dioxin Study if local consumption patterns are considered. The CDC level of concern applies generally to residential soil, and other exposure patterns should be considered for other soil contamination situations.

The estimates of lifetime cancer risks used as the basis in the three assessments do not differ greatly. The difference in potency among the three original assessments is less than an order of magnitude. With the revised potency estimates for the CDC and FDA, the differences are less than a factor of 6.

APPENDIX A REFERENCES

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APPENDIX B. FATE OF 2,3,7,8-TCDD IN SOIL

B.1. Introduction

This appendix is intended to assist in evaluating the data from Tiers 3 through 7 of the National Dioxin Study, since an understanding of the processes that affect the fate of 2,3,7,8-TCDD is important for characterizing the impacts of 2,3,7,8-TCDD. It summarizes the current literature available on the fate of 2,3,7,8-TCDD in soil and identifies the predominant fate processes. Issues particularly relevant to the objectives of the National Dioxin Study are highlighted, such as information on observed distribution and migration of 2,3,7,8-TCDD from sites contaminated with production wastes or herbicide formulations. Data on 2,3,7,8-TCDD bioaccumulation in plants and animals as a result of soil contamination are also summarized.

B.2. Physicochemical Properties of 2,3,7,8-TCDD

Pure 2,3,7,8-TCDD is a white crystalline solid with a molecular weight of 321.9 and a melting point of 302-305°C. The solubility of 2,3,7,8-TCDD in water is low (3.17×10^{-4} mg/L); solubility in organic solvents, particularly nonpolar organic solvents, is higher. Table B-1 presents some environmentally relevant properties of 2,3,7,8-TCDD.

On the basis of its physicochemical properties, 2,3,7,8-TCDD is not expected to be particularly mobile in the soil environment. Partition coefficient data (log K_{OW} and log K_{OC}) suggest that it will rapidly absorb onto the organic matter in soil, and that desorption will be slow. It has been found that dioxins are more tightly bound to soils with relatively high organic content than to sandy soils (EPA, 1980). The enhanced solubility of 2,3,7,8-TCDD in organic solvents, particularly nonpolar solvents, may be an important factor in its environmental mobility, since 2,3,7,8-TCDD released to the environment is generally present as a contaminant in organic formulations (aerial spraying, production wastes) or stored along with other organic solvents (landfills). Bioaccumulation of 2,3,7,8-TCDD is expected to occur and has been reported for fish, cattle, rodents, and other wildlife (EPA, 1980).

B.3 Fate Processes in Environmental Soils

B.3.1. Observed Distribution and Persistence in Soil

Several authors have discussed the persistence and distribution of 2,3,7,8-TCDD in environmental soils (NRCC, 1981; EPA, 1980; DiDomenico *et al.*, 1980, 1982; Young, 1981; Young *et al.*, 1983; Harrison and Crews, 1981; Wipf and Schmid, 1981; and

TABLE B-1

PHYSICAL AND CHEMICAL PROPERTIES OF 2,3,7,8-TCDD

Molecular formula	$C_{12}H_4Cl_4O_2$	U.S. EPA (1984a)
Molecular weight	321.9	U.S. EPA (1984a)
Melting point	302-305°C	U.S. EPA (1984a)
Decomposition temperature	>700°C	ADL (1981)
Vapor pressure (mm Hg)		
15°C	$1.02x10^{-10}$	Schroy et al. (1984)
25°C	$1.45x10^{-9}$	Schroy et al. (1984)
25°C	$7.04x10^{-10}$	Podoll et al. (1986)
30°C	$3.46x10^{-9}$	Schroy et al. (1985)
40°C	$1.60x10^{-8}$	Schroy et al. (1984)
55°C	$1.37x10^{-7}$	Schroy et al. (1985)
62°C	$3.73x10^{-7}$	Schroy et al. (1985)
Solubility (mg/L) at 25°C in:		
Water	$7.9x10^{-6}$	Adams and Blaine (1986)
Water	$1.9x10^{-5}$	MacKay and Shiu (1981)
Water	$3.17x10^{-4}$	Freeman and Schroy (1984)
Methanol	10	U.S. EPA (1984a)
n-Octanol	50	U.S. EPA (1984a)
Acetone	110	U.S. EPA (1984a)
Chloroform	370	U.S. EPA (1984a)
Benzene	570	U.S. EPA (1984a)
o-Dichlorobenzene	1400	U.S. EPA (1984a)
Henry's Law Constant (atm.m^3/mole)	$2.12x10^{-6}$	Schroy et al. (1983)
	$1.6x10^{-5}$	Podoll et al. (1986)
log K_{oc} (experimental)		
(calculated)	7.15-7.34	Jackson (1985)
	6.95	Jackson (1985)
log K_{ow}	6.15	Kenaga (1980)
	6.64	Marple et al. (1986)
	7.02	Burkhard & Kuehl (1986)
	6.15-7.28	U.S. EPA (1984a)
Bioconcentration Factors (BCF)		
(estimated)	$3.3x10^4$	NRCC (1981)
catfish	$2x10^3$	Dow Chemical Co. (1978)
rainbow trout	$3.3x10^4$-$8.6x10^4$	Mehrle (1986)
mosquito fish	$2.4x10^4$	Dow Chemical Co. (1978)
	$2.4x10^2$-$1.5x10^4$	Dow Chemical Co. (1978)

Thibodeaux, 1983). In spite of its strong sorptive properties, 2,3,7,8-TCDD has been found distributed vertically through the uppermost soil layers and horizontally beyond the boundaries of the initial contaminated zone. The studies at Air Force test sites and in Seveso, Italy provide some data on the vertical distribution of 2,3,7,8-TCDD in soils. These studies are summarized below.

Air Force Test Sites

The vertical distribution patterns of 2,3,7,8-TCDD in soil at Air Force test sites that had been repeatedly sprayed with herbicide orange formulations have been described by EPA (1980) and are summarized in Table B-2. The data indicate some vertical migration, with most of the 2,3,7,8-TCDD remaining in the upper 6 in. of soil. Each data set reported in Table B-2 corresponds to unique spray conditions and is used here only to illustrate potential vertical distribution patterns. Furthermore, sampling techniques used for sets D, E and F resulted in cross-contamination; the EPA (1980) reported that later studies at the same site showed no contamination below 6 in. Data for samples collected from Eglin Air Force Base 414 days after herbicide orange application (data set B) indicated that soil penetration by the herbicide was greater than that by 2,3,7,8-TCDD. For example, herbicide orange concentrations of 160 ppm and 20 ppm were measured at 24-30 in. and 30-36 in., respectively (Young et al., 1976).

Seveso, Italy

After the July 1976 industrial accident at the ICMESA plant in Seveso, Italy, the vertical distribution of 2,3,7,8-TCDD down to a 30-cm (12-in.) depth was studied. DiDomenico et al. (1980) reported that, in general, concentrations of 2,3,7,8-TCDD dropped sharply in the top 8 cm (3 in.), regardless of sampling site locations or 2,3,7,8-TCDD level. Conversely, 2,3,7,8-TCDD levels remained relatively constant from 8-cm to 24-cm depths. The concentration levels detected more than 8 cm below the surface were approximately one order of magnitude less than the levels detected down to 8 cm. Furthermore, the highest levels of 2,3,7,8-TCDD were not found in the uppermost soil layer (0.5 cm), but most often in the second (0.5-1.0 cm) or third (1.0-1.5 cm) layers.

DiDomenico et al. (1980) reported a significant difference (p less than 0.05) in the 2,3,7,8-TCDD distribution patterns observed six months apart in 1976 and 1977. Compared with the 1976 distribution, a higher proportion of the total 2,3,7,8-TCDD was observed in deep soil layers (8 cm) in 1977. However, no significant differences in deep soil concentrations were reported over an eight-month period in 1977, suggesting that some stabilization occurred in 1977, as compared to 1976.

TABLE B-2

SOIL CONCENTRATIONS (PPT) of 2,3,7,8-TCDD AFTER AERIAL APPLICATION of HERBICIDE ORANGE[a]

Depth (in.)	Eglin AFB		Utah Test Site			
	A	B	C	D[b]	E[b]	F[b]
0-1	150					
1-2	160					
2-4	700					
4-6	44					
0-6		250	15,000	650	1,600	6,600
6-12		50	3,000	11	90	200
12-18		< 25	90			
18-24		< 25	120			
24-30		< 25				
30-36		< 25				

[a] Source: EPA (1980)

[b] Cross-contamination between sample depths was suspected because of sampling techniques

Belli et al. (1982) also examined the distribution of 2,3,7,8-TCDD at Seveso as a function of underground depth. They observed that 2,3,7,8-TCDD penetrated the soil to 20 cm or so, and that penetration occurred during the first 10-15 months. Furthermore, Belli et al. (1982) concluded that downward migration was the only transport mechanism at work, and that 2,3,7,8-TCDD was not removed from the surface layer via other mechanisms.

DiDomenico et al. (1982) examined the environmental persistence of 2,3,7,8-TCDD at Seveso. They concluded that mean 2,3,7,8-TCDD levels in soil diminished sharply in the first six months after contamination, followed by negligible changes in soil concentration levels. They also predicted that, 10 years later, significant levels of 2,3,7,8-TCDD (30-44% of those after six months) would remain. The initial observed decrease in soil concentrations levels occurred at an unexpectedly high rate compared to data in the literature, and was largely attributed to photodecomposition and heat-promoted volatilization. The authors reported the downward migration of the 2,3,7,8-TCDD remaining after the initial interaction with the environmental factors responsible for the initial disappearance.

B.3.2 Transformation and Transport Processes

The above discussion suggests that 2,3,7,8-TCDD can be removed from the soil surface and penetrate the soil column to some extent. Possible explanations for these observations include:

- Photodegradation;
- Volatilization and diffusion;
- Sorption processes, including desorption or comigration with organic solvents;
- Vertical or lateral translocation of 2,3,7,8-TCDD bound to soil particles;
- Biodegradation; and
- Accumulation in plants and animals.

These processes are discussed in the following subsections.

Photodegradation

In laboratory experiments, 2,3,7,8-TCDD readily undergoes photolysis (dechlorination) in the presence of a hydrogen donor (alcohols, ethers, hydrocarbons) and ultraviolet light (Helling et al., 1973; Crosby et al., 1971; Liberti et al., 1978). Dechlorination occurs preferentially at the 2,3,7,8-positions (Buser and Rappe 1978; Nestrick et al., 1980). Therefore, evolution of 2,3,7,8-TCDD from photolysis of highly chlorinated polychlorinated dibenzodioxins (PCDD) in the presence of organic solvents and ultraviolet light is unlikely.

In an aqueous suspension, no appreciable photolysis of 2,3,7,8-TCDD was detected; however, addition of a surfactant resulted in significant photolysis (Helling et al., 1973; Plimmer et al., 1973). In the absence of an organic solvent, little photodecomposition was observed for 2,3,7,8-TCDD spread on glass or marble, although some degradation was observed on silica gel and aluminum in the absence of an organic solvent (Liberti et al., 1978). Crosby et al. (1971) observed negligible photodegradation of pure 2,3,7,8-TCDD on glass and wet or dry soils.

The environmental significance of 2,3,7,8-TCDD photolysis is not well documented. However, several photolysis studies performed under environmental conditions or with commercial pesticide formulations indicated that photodegradation of 2,3,7,8-TCDD solutions may occur where pure 2,3,7,8-TCDD would have been stable. For instance, 2,3,7,8-TCDD in herbicide formulations such as Agent Orange, has been shown to photodecompose on glass plates, plant leaves and surface soils exposed to sunlight (Crosby and Wong, 1977). The reported loss of 2,3,7,8-TCDD over a period of six hours was greater than 50% from the glass plates, about 100% from the surface of leaves, and about 10% from the soil surface. These observations indicate that commercial herbicide formulations probably provide the hydrogen donor necessary for photolysis. Therefore, the loss of the hydrogen donor (i.e., herbicide) through various fate processes would probably result in a decreased degradation rate for 2,3,7,8-TCDD. DiDomenico et al. (1982) cited photodecomposition as a major factor in the initial (less than six months) rapid reduction of surface soil 2,3,7,8-TCDD concentrations in Seveso, Italy.

Volatilization

The ability to predict volatilization is generally limited to the aqueous phase, and is somewhat restricted by the uncertainty of the water solubility and vapor pressure data for 2,3,7,8-TCDD. NRCC (1981) reported a calculated volatilization transfer coefficient of 1.7×10^2 cm/day (cm/d); their equation, combined with a measured vapor pressure of 1.5×10^{-9} torr (Freeman and Schroy, 1984), yielded a calculated coefficient of approximately 2.2 cm/d.

Nash and Beall (1980) have demonstrated the volatility of 2,3,7,8-TCDD in both laboratory and field experiments. Although loss of 2,3,7,8-TCDD by volatilization is slow, this mechanism may be environmentally important in the absence of other transport or transformation processes.

Freeman and Schroy (1985) have suggested that volatilization is the principal removal mechanism for 2,3,7,8-TCDD in moist soil, and that the rate of removal from soil via volatilization is affected by temperature, depth in initial application, and moisture content of the soil. The surface temperature of soils is highly variable and is expected to significantly affect the rate of volatilization; the fluctuation of sub-surface temperatures is much less dramatic. Since volatilization is largely a surface phenomenon, the depth of the initial chemical application will also affect the apparent half-life of the compound in soil. The third factor affecting the rate of removal through volatilization is the moisture content of the soil. Volatilization of other chemicals of low water solubility and low volatility, such as pesticides, has reportedly decreased dramatically under dry soil conditions (Nash, 1985). The soil moisture content below which volatilization drops dramatically apparently corresponds to a monomolecular layer of water covering the soil surface (Harper et al., 1976). The volatilization rate was not greatly affected when the soil moisture content was increased above that corresponding to a monomolecular layer of water on soil.

In evaluating off-site transport of 2,3,7,8-TCDD from a production facility with on-site disposal, Thibodeaux (1983) predicted that vaporization from surface soils is the major transport process. Based on an average soil contamination of 1.3 ppb 2,3,7,8-TCDD, the total off-site transport rate was calculated to be 150-1240 g TCDD/yr.; the transport rate attributed to volatilization alone was calculated to be 120-1200 g/yr. The author cautioned that the lack of reliable water solubility and vapor pressure data contributed to uncertainty in the volatilization estimates.

Diffusion

Freeman and Schroy (1984) reported that the vertical transport of 2,3,7,8-TCDD in a soil column can be modeled as a temperature-driven diffusion process. They described peak 2,3,7,8-TCDD concentrations below the surface, and a very steep concentration profile as a function of depth. Soil temperature variations are expected to have a strong impact on the mobility in soil.

Freeman and Schroy (1984) studied Eglin Air Force Base biodegradation plots where Agent Orange containing 40 ppb 2,3,7,8-TCDD had been applied in 1972 to the bottom of 10-13 cm trenches that were then backfilled with soil. They demonstrated that the applied 2,3,7,8-TCDD had migrated about 10 cm in 12 years. Migration was observed above and below the point of application. All the 2,3,7,8-TCDD applied to the study plots was apparently still in the soil.

Sorption Processes

Sorption of 2,3,7,8-TCDD onto soil particles in the environment is expected to be rapid; subsequent soil/water equilibration and desorption, however, are slow (ADL, 1981). 2,3,7,8-TCDD is more tightly bound to soils of high organic content, and Harwood et al. (1985) reported that it becomes increasingly bound to soil as a function of time. Sorption of 2,3,7,8-TCDD onto soil can be predicted from octanol:water partition coefficient (K_{ow}) data and the organic carbon content (oc) of the soil according to the following two equations (Karickhoff et al., 1979):

$$\log K_{oc} = \log K_{ow} - 0.21; \text{ and } K_{soil} = K_{oc}\,(oc).$$

In addition to the organic content of soil, other factors that affect the sorption of 2,3,7,8-TCDD on environmental soils have been identified. Freeman and Schroy (1984) and Nash (1985) reported that 2,3,7,8-TCDD and other pesticides bind strongly to dry soils; mobility is increased in the presence of soil moisture. The medium in which 2,3,7,8-TCDD is dispersed at the time of soil application or environmental release is another factor. Since the solubility of 2,3,7,8-TCDD in organic solvents is generally greater than its solubility in water, partitioning to soils is likely to be less, depending on the dispersion medium, and 2,3,7,8-TCDD may be carried with the organic solvent. Increased migration of 2,3,7,8-TCDD in toluene or xylene was reported by Harwood et al. (1985); these authors also reported that migration at 40°C was significantly greater than at 10°C.

Harrison and Crews (1981) examined the soil contamination at a site used for storing and loading herbicide contaminated with 2,3,7,8-TCDD. They reported soil contamination above 1 ppb near the loading pad, with little soil contamination beyond 3 to 4 meters from the pad. 2,3,7,8-TCDD was detected at soil depths down to 1 meter; the authors concluded that the route of migration was transport with the herbicide.

The leaching of 2,3,7,8-TCDD from contaminated soils is largely an effect of solubilization and desorption of absorbed 2,3,7,8-TCDD. Jackson (1985) used three different procedures for generating aqueous leachate to examine the solubility of 2,3,7,8-TCDD in contaminated soils (8 ppb to 26,000 ppb). Experimental soil partitioning coeficients (K_p) were determined as the ratio of leachate concentration to soil concentration and were then used to compute K_{oc} values [$\log K_{oc} = \log (K_p/oc)$]. The K_{oc} values, based on experimental data, agreed well with previously reported K_{oc} data and indicated that the effect of desorption by leaching would be minimal for 2,3,7,8-TCDD.

Nash and Beall (1978) analyzed the 2,3,7,8-TCDD content of leachate samples from silvex-treated microagroecosystems. After the first two applications (days 0 and 35) of silvex containing 44 ppb 2,3,7,8-TCDD, water leachate samples showed no detectable 2,3,7,8-TCDD at detection limits of 0.0001 ppt. Following a third application (day 77) of silvex formulations containing 7500 ppb

2,3,7,8-TCDD, water leachate samples were shown to be contaminated. Maximum concentrations of 0.05 to 0.06 ppb were calculated for leachate samples taken 7 weeks after the third application.

These studies suggest that, in spite of its strong sorptive properties, 2,3,7,8-TCDD may migrate to some extent in soil systems. Possible explanations for this behavior include exceedence of the sorptive properties of the soil, increased solubilization of the sorbed 2,3,7,8-TCDD by the organic solvents, or migration of the 2,3,7,8-TCDD with the dispersing medium.

Translocation

Since 2,3,7,8-TCDD is strongly adsorbed to soil particles and the effects of aqueous leaching are minimal, translocation of soil-bound 2,3,7,8-TCDD is expected to be a major fate process. Monteriolo et al. (1982), Wipf and Schmid (1981), and DiDomenico et al. (1982) cited the translocation of 2,3,7,8-TCDD adsorbed on soil colloids and soil particles and movement through soil fissures as the predominant transport mechanism responsible for the vertical movement of 2,3,7,8-TCDD in soils at Seveso, and particularly for the elevated concentrations observed in deep soils. Matsumura and Benezet (1973) hypothesized that any movement of 2,3,7,8-TCDD in the soil environment would occur via movements of soil and dust particles. Young (1981) reported movement of 2,3,7,8-TCDD by wind/water erosion and burrowing rodents.

Transport of TCDD-contaminated soil into surface waters by erosion has been described by several authors (Thibodeaux, 1983; EPA, 1980; Kleopfer and Zirschky, 1983). The 2,3,7,8-TCDD is expected to remain strongly adsorbed and persist in the suspended sediment or bottom sediment of the surface waters. Isensee and Jones (1975) concluded that 2,3,7,8-TCDD adsorbed to soil would result in significant concentrations dissolved in water, only if the soil were washed into a small body of water.

Biodegradation

Dioxin exhibits relatively strong resistence to microbial degradation in soils (Phillip et al., 1981; Wipf and Schmid, 1981; and Young, 1981). In addition, Matsumura and Benezet (1973) tested 100 strains of microorganisms, which had previously shown an ability to degrade persistent pesticides, for their ability to degrade 2,3,7,8-TCDD. Only five strains showed some ability to degrade this compound.

Young et al. (1978) attributed loss of 2,3,7,8-TCDD in soil plots to biodegradation, with half-lives ranging from 225 to 275 days. Using subsequent data from the same plots, Freeman and Schroy (1984) concluded that all of the initial 2,3,7,8-TCDD was still contained in the test plots and attributed the apparent biodegradation to temperature-driven diffusion, variations in the initial loadings, and analytical problems.

Plant Uptake

The limited data on plant uptake of 2,3,7,8-TCDD from contaminated soil indicated that small amounts are accumulated in plants. In an early study involving soil application of 0.06 ppm 2,3,7,8-TCDD formulations, a maximum of 0.15% of the 2,3,7,8-TCDD was detected in the above ground portion of oats and soybeans; no 2,3,7,8-TCDD was detected in the harvested grains (Kearney et al., 1973). In the same study, no translocation of 2,3,7,8-TCDD applied to leaves of young oat and soybean plants was observed. Isensee and Jones (1971) and Matsumura and Benezat (1973) reported that 2,3,7,8-TCDD was neither adsorbed by oat or soybean seeds nor taken up from the soil by the mature plants; young plants, however, did accumulate up to 40 ppb 2,3,7,8-TCDD. Jensen et al. (1983) analyzed rice grain from fields in Texas, Arkansas, and Louisiana that had been sprayed with 2,3,7,8-TCDD herbicides. No residues were detected in these samples or in 30 other samples of rice from U.S. retail stores.

Cocucci et al. (1979) examined the absorption and bioaccumulation of 2,3,7,8-TCDD in fruits and kitchen-garden plants from the contaminated zone near Seveso. Dioxins were measured in all samples of fruit, new leaves, twigs and cork from fruit trees. The 2,3,7,8-TCDD levels on leaves were typically 3 to 15 times higher than the fruit concentrations, which were the lowest. Cork concentrations were generally higher than those of leaves but lower than twigs. The authors concluded that 2,3,7,8-TCDD is translocated from soil to the aerial parts of the plants, and suggested that losses from fruits and leaves may account for the relatively low concentrations observed in those samples.

Wipf and Schmid (1981) reported that the contamination of fruit in the area near Seveso was generally limited to the peel, and that plant uptake was not significant. They reported that 68% of the contamination observed in carrots remained in the wash water, 29% was in the peels, and only 3% in the edible portion. These data strongly suggested that contamination of vegetative matter was due primarily to deposition of local dust or adsorption rather than systemic uptake. Young (1981) also reported plant data suggesting that stem/leaf contamination is probably from soil particles, and that root contamination is likely from incorporation of soil particles into the epidermis of the root tissue.

Facchetti et al. (1985) examined the uptake of 2,3,7,8-TCDD by maize and bean plants grown under open and enclosed conditions in pots of soil containing between 1 and 752 ppt 2,3,7,8-TCDD.

The root samples showed high concentrations of 2,3,7,8-TCDD due to adsorption. Transfer to the aerial parts through the roots appeared to be limited; contamination of the aerial parts through the process of volatilization was suggested.

Accumulation in Animals

Contamination of fish downstream of sites with 2,3,7,8-TCDD-contaminated soil is well documented and summarized (EPA, 1980; NRCC, 1981; and Firestone et al., 1985). For example, levels of 2,3,7,8-TCDD residues exceeding 100 ppt were reported in fish collected from the Tittabawassee River, Saginaw Bay, Lake Huron, Arkansas River, and the Bayou Meto; all locations were near plants that manufactured 2,4,5-T (Stalling et al., 1983; Mitchum et al., 1980; Harless et al., 1982). Kleopfer and Zirschky (1983) found 2,3,7,8-TCDD residues of up to 55 ppt in whole fish from the Spring River in Missouri, downstream of 2,3,7,8-TCDD-contaminated disposal sites. In most studies, detection limits in sediments were not low enough to allow correlation of fish concentrations with sediment concentrations. However, translocation of 2,3,7,8-TCDD-containing particles is generally thought to be the origin of contamination in the river. Fish bioconcentration factors reported by the Dow Chemical Co. (1978) have been summarized by Kloepfer and Zirschky (1983) as follows: 2000 (catfish), 6600 (rainbow trout), 24,000 (mosquito fish).

The results of an Air Force study described by the EPA (1980) suggested accumulation of 2,3,7,8-TCDD in birds and rodents collected from a site used for extensive testing of herbicide formulations. The accumulation of 2,3,7,8-TCDD residues in animals from contaminated areas near Seveso has also been evaluated. Liver samples of rabbits, poultry, cattle, and horses from the contaminated areas were found to contain 2,3,7,8-TCDD concentrations greater than 1 ppb (Monteriolo et al., 1982).

Milk samples from dairy farms near the ICMESA plant in Seveso were analyzed for 2,3,7,8-TCDD residues (Fanelli et al., 1980). Highly variable results were reported, with a maximum concentration in milk of 7900 ppt. It was later determined that some of the fodder given to the dairy cows had been harvested from the most contaminated zone (Monteriolo et al., 1982).

Potential accumulation of 2,3,7,8-TCDD residues in the fat of cattle and other livestock is also a concern; however, conflicting data on this subject have been reported. Shadoff et al. (1977) cited no evidence of 2,3,7,8-TCDD bioconcentration in the fat of cattle fed ronnel insecticide contaminated with 2,3,7,8-TCDD. The detection limits were 5 to 10 ppt.

Other researchers have analyzed fat from cattle grazing on land sprayed with 2,4,5-T herbicides (EPA, 1980). One study

(Kocher et al., 1978) showed detectable 2,3,7,8-TCDD residues in fat (4 to 16 ppt) in five of eight samples collected. A second study (Meselson et al., 1978) reported that 11 of 14 samples contained detectable 2,3,7,8-TCDD residues; the four highest values ranged from 12 to 70 ppt. A third study (Solch et al., 1980) detected 2,3,7,8-TCDD residues in 13 of 102 samples of beef fat at concentrations ranging from 10 to 54 ppt. Harless et al. (1980) reported two positives (20-60 ppt) out of 85 beef fat samples analyzed; in the same study, 2,3,7,8-TCDD was not detected in 43 beef liver samples.

B.4 Summary

The 2,3,7,8-TCDD contamination in soils is typically confined to the top 6-12 inches, but mostly in the top 6 inches. Several studies have reported removal of 2,3,7,8-TCDD from the uppermost (0-0.5 cm) surface of the soil. The persistence of 2,3,7,8-TCDD has been characterized as having two phases: an initial rapid decrease in soil levels, followed by a period approaching steady-state conditions. Most studies have found elevated 2,3,7,8-TCDD levels more than 10 years later.

Most of the observed 2,3,7,8-TCDD removal from soil systems occurs within a relatively short period of time (less than six months). Removal from the surface is largely due to photodegradation at the time of application, volatilization, or temperature-driven diffusion into the soil column. Biodegradation is not expected to be an important fate process.

Once 2,3,7,8-TCDD is bound to soil particles, its persistence in the environment increases significantly. Bioavailability of adsorbed 2,3,7,8-TCDD is low, and plant uptake is not expected to be a significant factor in the movement of 2,3,7,8-TCDD. Vertical and horizontal translocations of 2,3,7,8-TCDD bound to soil particles through wind/water erosion are predominant transport pathways and are probably responsible for elevated sediment concentrations in some surface water bodies near areas of soil contamination. Biotranslocation by burrowing animals and soil insects may also be an important transport process.

Under most environmental conditions, the impact of 2,3,7,8-TCDD-contaminated soil on underlying groundwater is not expected to be important. Notable exceptions where groundwater contamination may occur are in sandy soils or other soils of low organic content, and in areas where other organic solvents may be available to increase the mobility of adsorbed 2,3,7,8-TCDD.

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APPENDIX C ESTIMATION PROCEDURES AND RESULTS

A detailed description of the statistical site selection procedures used in this study is provided in RTI (1984). As a result of information gained during the course of this study, some modifications to the estimation procedures suggested by RTI (1984) were required. This appendix summarizes the site selection and estimation procedures that were used, as well as the estimated percent of contaminated sites for each tier.

C.1 Tier 3

C.1.1 Site Selection

Initially, the EPA identified 258 facilities as Tier 3 sites from its FIFRA and TSCA Enforcement System (FATES). A stratified random sample of 50 facilities was selected from seven strata. The first stratum consisted of the 31 largest facilities (those handling at least 100,000 pounds total of active ingredients). The remaining 227 facilities were classified into six strata, according to EPA region (Table C-1).

Fifty-four 2,4,5-TCP and erbon formulators were discovered in the FATES file after the initial sample of 50 facilities had been selected. Two additional strata were created to include these 54 new sites. One stratum consisted of the eight largest facilities (handling more than 100,000 pounds) and the other consisted of the remaining 46. Two plants were randomly selected from the large facilities and 9 from the remaining facilities to make a total of 61 statistically selected sites in nine strata from an overall sample frame of 312 facilities (Table C-1). Within each stratum, facilities to be sampled were selected with equal probability and without replacement.

C.1.2 Estimation Procedures

The Percent of Eligible Sites

A number of the sites selected in Tier 3 were ineligible (did not handle tier 3 compounds or were warehouses). The percentage of eligible sites in the sampling frame ($\hat{P}_e$) was calculated as follows:

$$\hat{P}_e = \hat{N}_d/N \times 100 \qquad \text{(C-1)}$$

where:

TABLE C-1
SUMMARY OF TIER 3 STATUS

Stratum	Frame Count N(h)	Sample Selections n(h)	Sampling Weight N(h)/n(h)	Number of Sites Sampled	Number of Sites Contaminated	Number That Will Not be Sampled	Number Ineligible
1	31	6	5.16667	5	1	0	1
2	43	8	5.37500	4	3	2	2
3	39	8	4.87500	5	1	1	2
4	53	10	5.30000	9	1	0	1
5	37	7	5.28571	5	0	1	1
6	29	6	4.83333	5	0	0	1
7	26	5	5.20000	1	0	2	2
8	8	2	4.00000	2	0	0	0
9	46	9	5.11111	5	0	1	3
	312	61		41	6	7	13

Sampling Weights Used for Weighting Class Adjustment

Stratum	Selections n(h)	Sampling Weight N(h)/n(h)
1 Large Production Facilities	6	5.16667
2 EPA Regions I, II and II	6	7.16667
3 EPA Regions IV	7	5.57143
4 EPA Region V	10	5.30000
5 EPA Region VI	6	6.16667
6 EPA Region VII	6	4.83333
7 EPA Regions VII, IX and X	3	8.66667
8 Other Large Production Facilities	2	4.00000
9 Miscellaneous	8	5.75000

$\hat{N}_d$ = the total number of domain d eligible sites; and
N = the total number of sites in the frame.

$\hat{N}_d$ can be estimated as follows:

$$\hat{N}_d = \sum_{h=1}^{H} \sum_{i=1}^{n(h)} W(h,i) \quad \delta_d(h,i) \qquad \text{(C-2)}$$

where:

H = the number of strata;
n(h) = the number of sites selected from the h-th stratum;
W(h,i) = the sampling weight of the i-th selection of the h-th stratum; and
$\delta_d(h,i)$ = the indicator of domain d membership status of the h-th stratum
= 1 if the h, i-th selection is an eligible site of domain d status, and 0 otherwise.

The variance for the estimate of $\hat{P}_e$ can be calculated as follows:

$$\mathrm{Var}(\hat{P}_e) = \left[\sum_{h=1}^{H} \left(\frac{N(h)}{N} \right)^2 \left(\frac{N(h)-n(h)}{N(h)-1} \right) \left(\frac{\hat{P}_e(h)(1-\hat{P}_e(h)}{n(h)-1} \right) \right] \times 100^2 \qquad \text{(C-3)}$$

where:

N(h) = the total number of sites in the frame count from the h-th stratum; and
$\hat{P}_e(h)$ = the proportion of eligible sites in stratum h.

The estimate of the eligible Tier 3 sites and its associated standard error are shown in Table C-2.

Percent of Contaminated Sites

Three estimates were calculated for the percent of contaminated sites in Tier 3. The three estimates were based on different assumptions about the seven missing sites (those sites that could not be sampled due to paving or extensive earthwork). A lower bound estimate was calculated assuming that the seven sites without data were not contaminated. The point estimate assumed the seven sites were similar in frequency of contamination to those with data. An upper-bound estimate assumed all seven sites to be contaminated.

The lower and upper bounds are the lowest and highest values of the estimate of the percent of contaminated sites.

TABLE C-2
ESTIMATION RESULTS FOR TIER 3

	Estimate	Percent (%)	Standard* Deviation (%)
1.0	Percent of eligible sites out of the original 312 sites in FATES data base	79	5
2.0	Percent of contaminated sites (based on the 245 eligible sites)		
	Lower Bound	13	4
	Point Estimate	16	5
	Upper Bound	28	5
3.0	Percent of contaminated sites out of 312 sites in FATES		
	Lower Bound	10	3
	Point Estimate	12	4
	Upper Bound	22	5

* Calculated as the square root of the variance

Cochran (1977) suggested using confidence limits formed by using the lower and upper bound estimates as the most conservative estimate of the potential bias.

The estimates for the percent of contamination were calculated for two different populations. The first is an estimate of the percent of contaminated facilities of the eligible sites (those that actually formulated Tier 3 compounds (79% of the total Tier 3 sites). The second is the estimate of the percent of contaminated sites of the 312 sites that had originally been identified from the FIFRA and TSCA Enforcement System (although not all of these sites had actually formulated Tier 3 compounds). Of the 61 statistically selected sites, 13 were considered ineligible because further information revealed that no Tier 3 compounds had actually been handled, or the site was a warehouse.

Percent of Contaminated Sites (of Eligible Sites)

The percent ($\hat{P}_d$) of domain d sites contaminated with dioxin of those formulating Tier 3 compounds was estimated by:

$$\hat{P}_d = \hat{Y}_d/\hat{N}_d \times 100 \qquad \text{(C-4)}$$

where:

$\hat{Y}_d$ = the estimated total domain d eligible sites contaminated with dioxin; and
N_d = the total number of domain d eligible sites.

The denominator of $\hat{P}_d$ is estimated as shown in Equation (C-2). The numerator is estimated as follows:

$$\hat{Y}_d = \sum_{h=1}^{H} \sum_{i=1}^{n(h)} W(h,i)\ \delta_d(h,i)\ y\ (h,i) \qquad \text{(C-5)}$$

where:

y(h,i)= the indicator of dioxin contamination for the i-th site within the h-th stratum. y(h,i) = 1 if the h, i-th site is contaminated, and 0 otherwise.

The lower bound on the proportion estimate was calculated by assuming y(h,i)=0 for the seven missing sites (assumes they are not contaminated). The upper bound was calculated assuming y(h,i)=1 for the missing sites (assumes they are contaminated).

The point estimate was calculated using weighting class adjustments, assuming that all of the missing sites are similar to the sites for which there is information.

The weighting class adjustments were calculated by modifying the sample sizes for each of the strata to reflect the total number of respondents (sites). Ineligible sites were treated as respondents in this calculation. The revised sample selection (n(h)) equals the total number of sites minus the missing sites in each stratum. All of the recalculated sampling weights are shown in Table C-1.

The variance of $\hat{P}_d$ is estimated by (Cochran, 1977, pp. 143-144):

$$\text{Var}\,(\hat{P}_d) = \frac{1}{(\hat{N}_d)^2}\left[\sum_{h=1}^{H} \frac{N(h)[N(h)-n(h)]\; n_d(h)}{n(h)\;[n(h)-1]} (\hat{P}_d(h)\;[1-\hat{P}_d(h)] + [1 - \frac{n_d(h)}{n(h)}]\;[\hat{P}_d(h) - \hat{P}_d]^2)\right] \times 100^2 \qquad \text{(C-6)}$$

where:

$N(h)$ = the total number of sites in the frame count for the h-th stratum;

$n_d(h)$ = the total number of domain d eligible sites in the h-th stratum; and

$\hat{P}_d(h)$ = the proportion of domain d sites contaminated with dioxin in the h-th stratum.

Percent of Contaminated Sites (of the 312 Sites Identified in Fates)

The estimate of the percent ($\hat{P}_f$) of contaminated sites of those 312 Tier 3 originally identified in FATES was calculated as follows:

$$\hat{P}_f = \hat{Y}_d/N \times 100 \qquad \text{(C-7)}$$

The estimate of the variance associated with $\hat{Y}_d$ was calculated as follows (Cochran, 1977, pg. 143):

$$\text{Var}\,(\hat{Y}_d) = \left[\sum_{h=1}^{H} \frac{N(h)\;(N(h)-n(h))}{n(h)\;(n(h)-1)} \sum_{i=1}^{n(h)} \left((\delta(h,i)y(h,i))^2 - \frac{\left(\sum_{i=1}^{n(h)} \delta(h,i)y(h,i)\right)^2}{n(h)}\right)\right] \times 100^2 \qquad \text{(C-8)}$$

The variance associated with $\hat{P}_f$ can be calculated as follows:

$$\text{Var}\ (\hat{P}_f) = \frac{\text{Var}(\hat{Y}_d)}{N^2} \qquad \text{(C-9)}$$

The results of the estimates of proportion of contaminated sites and their associated standard error are summarized in Table C-2.

C.2 Tier 6

C.2.1 Site Selection

Initially, EPA identified 61 facilities belonging to this tier. These 61 facilities were grouped by EPA region, and a cluster sample approach was used to statistically select 19 of them for sampling. There were five clusters, each with four facilities. One facility was selected twice and is replicated in the data set used for estimation of the percent of contamination in the tier. The facilities were selected with equal probability and without replacement.

Six additional sites were identified in the FATES data base after the initial 19 were selected. Rather than rework the selection model to account for the additional sites, all six sites were selected for sampling as individual clusters. Thus a total of 25 sites (26 including the one selected twice) were statistically selected from a total frame of 67 sites (Table C-3).

C.2.2 Estimation Procedures

Estimate of the Percent of Eligible Sites

Ten of the Tier 6 sites were ineligible (did not produce Tier 6 compounds). The percentage of eligible sites in the frame ($\hat{P}_e$) was calculated as for Tier 3 using equation (C-1) (Table C-4). The variance was estimated by:

$$\text{Var}\ (\hat{P}_e) = N\,\frac{N-n}{C\,(C-1)} \left[\sum_{c=1}^{C} \hat{P}_e(c)^2 - C\,\hat{P}_e^{\,2} \right] \times 100^2 \qquad \text{(C-10)}$$

where:

C = the number of clusters; and

$\hat{P}_e(c)$ = the percentage of eligible sites in cluster c.

TABLE C-3
SUMMARY OF TIER 6 STATUS

Cluster	Sample Selections n(h)	Sampling Wts. N(h)/n(h)	Number Sampled to Date	Number Contaminated	Number Ineligible
1	4	3.05	3	0	1
2	4	3.05	3	0	1
3	4	3.05	3	1	1
4	4	3.05	3	1	1
5	4	3.05	2	1	2
6	1	1.0	0	0	1
7	1	1.0	0	0	1
8	1	1.0	0	0	1
9	1	1.0	1	0	0
10	1	1.0	0	0	1
11	1	1.0	1	0	0
	26		16	3	10

Total number of Tier 6 sites: 67

TABLE C-4
ESTIMATION RESULTS FOR TIER 6

Estimate	Percent (%)	Standard Deviation (%)
1.0 Percent of eligible sites out of the 67 originally identified Tier 6 sites	67	21
2.0 Percent of contaminated sites (of eligible sites)	14	5
3.0 Percent of contaminated sites (of 67 sites originally identified as Tier 6 sites)	9	5

Percent of Contaminated Sites

An estimate was calculated for the percent of contaminated sites in Tier 6 as there were no missing sites in this tier.

As for Tier 3, the estimate of the percent of contamination was calculated for two different populations. The first was an estimate of the percent of contaminated sites of those actually produced Tier 6 compounds. The second was the estimate of the percent of contaminated sites out of the total number of sites (67) that had been originally identified as Tier 6 sites.

Percent of Contaminated Sites (of those Producing Tier 6 Compounds)

The percent (P_d) of domain d eligible sites contaminated was estimated as described for Tier 3 (Equations C-4 and C-5). The variance of P_d was estimated by (Kish, 1965, p. 132).

$$\mathrm{Var}\ (\hat{P}_d) = \frac{(N-n)\ C}{N(C-1)\ n^2} \left[\sum_{c=1}^{C} \left(n_d(c)\ [\hat{P}_d(c) - \hat{P}_d] \right)^2 \right] \times 100^2 \qquad (C-11)$$

where:

$n_d(c)$ = the total number of domain d eligible sites in cluster c;
C = the number of clusters; and
$\hat{P}_d(c)$ = proportion of contaminated sites in cluster c

Percent of Contaminated Sites (out of the 67 Sites Indentified as Tier 6 Sites)

The percent of contaminated sites of the 67 sites originally identifed as Tier 6 was calculated as for Tier 3 (Equation C-7). The variance associated with the estimate of the proportion of contaminated sites from the total sites was calculated as follows:

$$\mathrm{Var}\ (\hat{P}_f) = \frac{\mathrm{Var}\ (\hat{Y}_d)}{N^2}, \qquad (C-12)$$

where:

$$\mathrm{Var}\ (\hat{Y}_d) = \frac{N-n}{N}\ \frac{C}{(C-1)} \left[\sum_{c=1}^{C} (W(c,i)\ \ \delta(c,i)y(c,i)) - \frac{\hat{Y}_d^{\,2}}{C} \right] \times 100^2 \qquad (C-13)$$

where:

W(c,i) = sample weight of the i-th site in the c-th cluster;
δ(c,i) = 1 if the C, i-th selection is a member of domain eligible sites and 0 otherwise; and
y(c,i) = 1 if the h,i-th site is contaminated, and 0 otherwise.

Table C-4 summarizes the estimation results for Tier 6.

C.3 Tier 7

C.3.1 Urban Soils

Site Selection

Three hundred sites were selected from the 1,761 sites in the Urban Soils Network of the National Soil Monitoring Program using a single stage, unstratified cluster design (Table C-5). Five clusters with 60 sites per cluster were selected. Each site was selected with equal probability. The Urban Soils Network has an unknown probability structure and thus cannot be considered as representative of urban soils in the nation. Therefore, the results can only be used to estimate the percentage of contaminated sites in the network.

Estimation Procedures - Percent of Urban Soils Contaminated

The methods described for Tier 6 were used to estimate the lower bound, upper bound and point estimate for the proportion of contaminated sites and the associated variances (Table C-6).

C.3.2. Rural Soils

Site Selection

Two hundred sites were selected from the 13,280 sites in the Rural Soils Network of the National Soils Monitoring Program, using a single-stage, unstratified cluster design (Table C-7). Five clusters of 40 sites per cluster were selected. The Rural Soils Network has an unknown probability structure and cannot be considered representative of rural soils in the nation. Therefore, the results can be used only to estimate the percentage of contaminated sites in the network.

Because of the large number of missing sites, a sub-sample of 20 sites was drawn from the 59 sites that initially had missing documentation (Kroner, 1985). Table C-7 summarizes the sample and the sub-sample for rural soils.

TABLE C-5
SUMMARY OF TIER 7 STATUS FOR URBAN SOILS

Cluster	Sample Selections n(h)	Sampling Weight	No. of Sites Sampled	No. of Sites Contaminated	No. of Sites with No Data Available
1	60	5.87	47	3	13
2	60	5.87	42	3	18
3	60	5.87	42	5	18
4	60	5.87	46	4	14
5	60	5.87	44	2	16
	300		221	17	79

Total in Tier 7 urban soils: 1,761

Sampling Weights Used for Weighting Class Adjustment

Cluster	Sampling Weight N(h)/n(h)
1	7.49362
2	8.38571
3	8.38571
4	7.65652
5	8.00455

TABLE C-6

ESTIMATION RESULTS FOR TIER 7 URBAN SOILS NETWORK

Estimate	Percent (%)	Standard Deviation (%)
Percent of Contaminated Sites		
Lower Bound	6	1
Point Estimate	8	1
Upper Bound	32	2

TABLE C-7

SUMMARY OF TIER 7 STATUS FOR RURAL SOILS

Cluster	Sample Selections n(h)	Sampling Weight	Total That Were Not Included in the Subsample Frame	Number Sampled	Number Contaminated	Number That Will Not Be Sampled
1	40	66.40	29	25	0	4
2	40	66.40	30	27	0	3
3	40	66.40	26	23	0	3
4	40	66.40	30	27	1	3
5	40	66.40	26	22	0	4
	200		141	124	1	17

SUBSAMPLE

Cluster	Total Included in the Subsample Frame	Number Selected from Frame to Be Sampled*	Sampling Wt	Number Sampled	Number Contaminated	Number That Will not be Sampled
1	11	7 (4)	104.34286	3	0	4
2	10	4 (3)	166.00000	4	0	0
3	14	6 (5)	154.93333	4	0	2
4	10	4 (3)	166.00000	2	0	2
5	14	5 (5)	185.92000	1	0	4
	59	26 (20)		14	0	12

* Note: After the subsample frame was developed, some additional sites were found from the subsample which were not part of the subsample selected; 3 in cluster 1, and 1 each in clusters 2, 3 and 4. Numbers in parentheses represent the original number selected from the frame.

Estimation Procedures - Percent of Rural Soils Contaminated

The methods described for Tier 6 were used to estimate the lower bound, upper bound, and point estimate for the percent of contaminated sites and the associated variances (Table C-8). As a result of the large amount of missing data, a two-phase or double sampling plan was used (Hansen and Hurwitz, 1946). In the sub-sample that was selected many sites could not be found. However, some additional sites not selected for the sub-sample were subsequently found. All available sites were used to estimate the sub-sample values, and the number of sites in each cluster [n_2(c)] were calculated based on the number of sites that were found.

For the cluster elements that were not in the sub-sample, the weight W(c,i) remained the same as before (66.40000). Missing sites were handled as in previous tiers, and the estimates included an upper/lower bound and point estimate (weighting clss adjustment). New sampling weights [W_2(c,i)] were calculated for cluster elements that were in the sub-sample as follows (Table C-9):

$$W_2(c,i) = \frac{N_{2(c)}}{n_2(c)} \quad W\,(c,i) \qquad \text{(C-14)}$$

where,

$N_2(c)$ = the total number of sites in the c-th cluster for which locations were originally unknown, and,

$n_2(c)$ = the size of the sub-sample selected from the c-th cluster.

C.3.3 NASQAN and Benchmark Stations

Site Selection

The sampling frame for NASQAN and benchmark stations consisted of 554 sites. Of these, 102 stations were selected for sampling. From the 452 remaining stations a stratified random sample of 100 stations was selected among 10 strata (Table C-10).

Estimation Procedures - Percent of Fish Sites Contaminated

The estimates of the percents and associated variances for Tier 7 fish sites were calculated using the method outlined by RTI (1984). The sampling weights for the weighting class adjustment calculations are shown in Table C-10.

TABLE C-8

ESTIMATION RESULTS FOR TIER 7 RURAL SOILS NETWORK

Estimate	Percent (%)	Standard Deviation (%)
Percent of Contaminated Sites		
Lower Bound	0.5	0.4
Point Estimate	0.6	0.6
Upper Bound	23	4

TABLE C-9

SAMPLING WEIGHTS USED FOR WEIGHTING CLASS ADJUSTMENT -- TIER 7 RURAL SOILS

Sample Cluster	Sampling Weight
1	77.02400
2	75.06087
3	73.77778
4	73.77778
5	78.72727
Subsample Cluster	
1	243.46667
2	166.00000
3	232.40000
4	332.00000
5	929.60000

TABLE C-10
SUMMARY OF TIER 7 FISH STATUS

Stratum	Frame Count N(h)	Sample Selections n(h)	Sampling Weight N(h)/n(h)	No. of Sites Sampled to Date	No. of Sites Contaminated	No. That Will Not be Sampled
1	16	4	4.00000	3	1	1
2	24	5	4.80000	4	0	1
3	18	4	4.50000	4	2	0
4	74	16	4.62500	15	1	1
5	63	14	4.50000	12	6	2
6	101	22	4.59091	19	4	3
7	19	4	4.75000	4	1	0
8	47	11	4.27273	11	0	0
9	45	10	4.50000	9	1	1
10	45	10	4.50000	9	1	1
	452	100		90	17	10

Sampling Weights Used for Weighting Class Adjustment

Stratum	Sample Selections n(h)	Sampling Weight N(h)/n(h)
1	3	5.33333
2	4	6.00000
3	4	4.50000
4	15	4.93333
5	12	5.25000
6	19	5.31579
7	4	4.75000
8	11	4.27273
9	9	5.00000
10	9	5.00000

The percent of contaminated sites was calculated as for Tier 3, with the elimination of the indicator variable for ineligible sites.

The variance of P for Tier 7 fish sites was calculated as follows (Cochran 1977, pp. 107-108):

$$\mathrm{Var}\ (\hat{P}) = \left[\sum_{h=1}^{H} \left[\frac{N(h)}{N}\right]^{2} \left[\frac{N(h) - n(h)}{N(h) - 1}\right] \left[\frac{\sigma^{2}(h)}{n(h)}\right] \right] \times 100^{2} \qquad \text{(C-15)}$$

The variance is estimated by substituting

$\hat{P}(h)\ [1 - \hat{P}(h)]\ /\ [n(h) - 1]$

where:

$\hat{P}(h)$ = the proportion of contaminated sites in the hth stratum

for the unknown quantity $\sigma^2(h)/n(h)$ in equation (C-15) as described in RTI (1984). The estimates for the proportion of contaminated sites and the associated standard deviation are shown in Table C-11.

The estimates of the percents of contaminated fish sites shown in Table C-11 apply to the 452 stations in the sample frame. However, 102 sites were selected from the networks before the probability sample was drawn. In order to provide an estimate of the proportion of contaminated sites in the NASQAN and Benchmark networks as a whole, a combined estimate was developed. A weighted percent was calculated using the percent of the contaminated 102 sites and the estimate of the proportion of contaminated sites of the 452. However, data are not available for all 102 sites. It was assumed that the sites for which data are available represented the 102, although it was not a probability sample and the bias is unknown. As a result, the variance associated with the percent of the contamination of the 102 sites cannot be estimated. The variance associated with the combined estimate is unknown, but would be greater than that associated with the proportion estimate for the 452 sites.

TABLE C-11
ESTIMATION RESULTS FOR TIER 7 - FISH

Estimate	Percent (%)	Standard Deviation (%)
1.0 Percent of Contaminated Sites (of 452 sites in Sample Frame)		
Lower Bound	17	3
Point Estimate	19	4
Upper Bound	27	4
2.0 Percent of Contaminated Sites of 102 Sites originally Selected	29	

(21 contaminated sites/73 sites with data)

3.0 Percent of Contaminated Sites in NASQAN and Benchmark Networks

$$\frac{(\text{Percent of contaminated sites from 1.0})(452)+(29)(102)}{554}$$

Estimate	Percent (%)	Standard Deviation (%)
Lower Bound	19	
Point Estimate	21	
Upper Bound	27	

APPENDIX C REFERENCES

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Appendix D - Analytical Data

TABLE D-1 RESULTS OF TIER 3 ANALYSES - STATISTICALLY SELECTED SITES

REGION	LOCATION DESCRIPTION:	MATRIX TYPE	# SAMPLED	# DETECTED	RANGE[A] (PPB UNLESS OTHERWISE NOTED)	# CONT[B]	DET LIMIT (PPB UNLESS OTHERWISE NOTED)
CONTAMINATED SITES[B]:							
2	NJ W. CALDWELL ROCKLAND CHEM. CO., INC.	SOIL	10	1	1.3	1	0.03 - 1.1
	NY FARMINGDALE FARMINGDALE GARDEN LABS, INC.	SOIL	25	1	17.6	1	0.1 - 0.94
3	WV ONA HOLDER CORP.	SOIL	36	0	ND	0	0.012 - 0.84
		SEDIMENT	5	0	ND	0	0.72 - 8 (PPT)
		FISH	3	3	0.5 - 2.9 (PPT)	3	0.05 - 0.3 (PPT)
		CLAM	1	0	ND	0	2.2 (PPT)
4	GA FORT VALLEY SECURITY CHEM. CO. (WOOLFOLK CHEM.)	SOIL	16	2	23 - 40	2	0.13 - 21
		SOIL	1	1	36.7 (PPT)	0	NA
5	IL CHICAGO HEIGHTS RIVERDALE CHEM. CO.	SOIL	14	13	1.1 - 364	14	NA
	MI GRAND LEDGE ETM ENTERPRISES (PARSONS)	SOIL	21	2	0.56 - 1.13	1	0.05 - 0.76
NOT CONTAMINATED SITES:							
1	NH NASHUA J HUBBARD, INC.	SOIL	9	0	ND	0	0.051 - 0.15
2	NJ CARLSTADT AIRWICK INDUSTRIES INC.	SOIL	21	0	ND	0	0.02 - 0.48
		SOIL	5	4	4 - 44 (PPT)	0	NA
	NJ LINDEN GAF CORPORATION	SOIL	20	0	ND	0	0.14 - 0.99
		SOIL	9	8	3.6 - 26.3 (PPT)	0	NA
3	PA ELLWOOD CITY CALGON CORP.	SOIL	41	0	ND	0	0.03 - 0.72
		SOIL	6	1	1.5 (PPT)	0	0.35 -0.56(PPT)

[A] SOIL/SEDIMENT LEVELS BASED ON DRY WEIGHT; BIOLOGICAL TISSUE LEVELS BASED ON WET WEIGHT

[B] CONTAMINATION DEFINED AS CONCENTRATION GREATER THAN OR EQUAL TO 1 PPB IN SOIL OR ABOVE DETECTABLE LEVELS IN OTHER MEDIA; SEDIMENT IS DEFINED AS SAMPLES WITH OVERLYING WATER SUPPORTING AQUATIC LIFE. SAMPLES FROM AREAS SUCH AS DRAINAGE DITCHES ARE CONSIDERED SOIL.

TABLE D-1 RESULTS OF TIER 3 ANALYSES - STATISTICALLY SELECTED SITES

REGION	LOCATION DESCRIPTION:	MATRIX TYPE	# SAMPLED	# DETECTED	RANGE[A] (PPB UNLESS OTHERWISE NOTED)	# CONT[B]	DET LIMIT (PPB UNLESS OTHERWISE NOTED)
3	PA PHILADELPHIA E.F. HOUGHTON	SOIL	40	0	ND	0	0.021 - 0.22
4	FL MARIETTA CHEMISURE PRODUCTS, INC. (DIXIE CHEM. CO.)	SOIL	16	0	ND	0	0.01 - 0.06
	FL MIAMI SPRINGS PET CHEMICALS INC.	SOIL	12	0	ND	0	0.01 - 0.08
	GA MACON BETZ LABS., INC.	SOIL	23	0	ND	0	0.01 - 0.58
		SOIL	7	7	1.3 - 16 (PPT)	0	NA
	NC HUNTERSVILLE MAINTENANCE SUPPLY SERV. CORP.	SOIL	27	0	ND	0	<0.5 - 5.8
	TN MEMPHIS MORTON PHARMACEUTICALS, INC.	SOIL	21	0	ND	0	0.01 - 0.21
5	IL CHICAGO HYSAN CORPORATION	SOIL	17	0	ND	0	0.02 - 0.37
	IL CHICAGO MORTON THIOKOL-VENTRON DIV.	SOIL	7	0	ND	0	0.11 - 0.65
	IL DES PLAINES RAMS HEAD CO.	SOIL	9	2	0.36 - 0.4	0	0.055 - 0.49
	IL ELGIN BLACK LEAF PRODUCTS CO.	SOIL	20	0	ND	0	0.02 - 0.67
	IL ROCHELLE HUB OIL CO.	SOIL	15	0	ND	0	0.14 - 0.86
	IN INDIANAPOLIS HUB STATES CORP.	SOIL	35	0	ND	0	0.1 - 0.94
	IN KINGSBURY D H & R CO. INC.	SOIL	40	0	ND	0	0.02 - 0.74
	MI OWOSSO AM. AEROSOL (DOW)	SOIL	21	0	ND	0	0.01 - 1

TABLE D-1 RESULTS OF TIER 3 ANALYSES - STATISTICALLY SELECTED SITES

REGION	LOCATION DESCRIPTION:			MATRIX TYPE	# SAMPLED	# DETECTED	RANGE[A] (PPB UNLESS OTHERWISE NOTED)	# CONT[B]	DET LIMIT (PPB UNLESS OTHERWISE NOTED)
	MN	MARSHALL	STANDARD CHEMICAL MFG CO.	SOIL	31	0	ND	0	0.01 - 0.63
	OH	SPRINGFIELD	ABLE PEST CONTROL INC.	SOIL	9	0	ND	0	0.03 - 0.48
6	TX	HOUSTON	DREW CHEMICAL CORP.	SOIL	14	0	ND	0	0.01 - 0.2
	TX	IRVING	MOHAWK LABS. DIV. OF NCH CORP.	SOIL	13	0	ND	0	0.02 - 0.81
	TX	SAN ANGELO	BES-TEX INSECT. CO. INC.	SOIL	38	0	ND	0	0.03 - 0.61
7	IA	EMMETSBURG	INSTITUTIONAL EQUIPMENT, INC. (PALO ALTO)	SOIL	53	0	ND	0	0.05 - 0.85
	IA	ESTHERVILLE	GOLDEN SUN FEEDS, INC.	SOIL DUST	34 3	0 0	ND ND	0 0	0.1 - 0.11 0.1 - 0.36
	IA	MALVERN	STANDARD CHEM. MFG. CO.	SOIL SEDIMENT DUST	16 15 5	0 0 0	ND ND ND	0 0 0	0.1 - 0.8 0.1 - 0.67 0.1 - 0.48
	MO	KANSAS CITY	NOVA PRODUCTS, INC.	SOIL	25	0	ND	0	0.03 - 0.77
	MO	MARYLAND HEIGHTS	CHEVRON CHEM. CORP.	SOIL	28	0	ND	0	0.05 - 0.7
	MO	N. KANSAS CITY	COLONY CHEM. CO. (PEUBLO CO.)	SOIL	13	0	ND	0	0.1 - 0.76
	MO	SAINT JOSEPH	FARMLAND IND. (MISSOURI CHEMICAL CO.)	SOIL	32	1	0.3 - 0.3	0	0.04 - 0.67
	MO	SEWARD	EASY CHEM. & MFG CO. INC.	SOIL	52	0	ND	0	0.1 - 0.47

TABLE D-1 RESULTS OF TIER 3 ANALYSES - STATISTICALLY SELECTED SITES

REGION	LOCATION DESCRIPTION:			MATRIX TYPE	# SAMPLED	# DETECTED	RANGE[A] (PPB UNLESS OTHERWISE NOTED)	# CONT[B]	DET LIMIT (PPB UNLESS OTHERWISE NOTED)
	MO	ST. LOUIS	DERRICK SOAP PRO. INC.	SOIL	27	0	ND	0	0.05 - 5.4
	MO	ST. LOUIS	NAVY BRAND MFG., CO.	SOIL	27	1	0.86	0	0.1 - 0.55
9	AZ	SCOTTSDALE	INDIANHEAD MFG.	SOIL	17	0	ND	0	0.1 - 0.61
	CA	BREA	PETROLITE	SOIL	16	0	ND	0	0.1 - 1.2

TABLE D-2 RESULTS OF TIER 3 ANALYSES - REGIONALLY SELECTED SITES

REGION	LOCATION DESCRIPTION:	MATRIX TYPE	# SAMPLED	# DETECTED	RANGE[A] (PPB UNLESS OTHERWISE NOTED)	# CONT[B]	DET LIMIT (PPB UNLESS OTHERWISE NOTED)
CONTAMINATED SITES:[B]							
3	VA ALEXANDRIA R.H. BOGLE CO.	SOIL	40	0	ND	0	0.07 - 0.89
		FISH-WHOLE	4	4	1.6 - 6.3 (PPT)	4	0.3 - 1.3 (PPT)
		FISH-FILET	4	3	1.9 - 5.0 (PPT)	3	0.4 - 1.3 (PPT)
		SEDIMENT	9	5	5.5 - 23 (PPT)	5	1.2 - 9.7 (PPT)
	VA NORFOLK SMITH DOUGLAS CO. (BORDEN)	SOIL	53	1	10.1	1	0.01 - 0.83
		DUST	10	0	ND	0	0.08 - 0.83
		OTHER	1	0	ND	0	0.12
4	FL BELLE GLADE CHEM. SPRAY, INC.	SOIL	19	2	0.2 - 3.0	1	0.01 - 60
		SEDIMENT	7	7	20.9 - 515 (PPT)	7	NA
5	IL BEDFORD PARK NALCO CHEM. CO.	SOIL	10	2	1.9 - 2.2	2	0.76 - 0.65
7	MO SAINT JOSEPH UNION CARBIDE	SOIL	26	23	0.13 - 39.1	16	0.11 - 1.04
9	CA SANTE FE SPRINGS MAGNA CORP.	SOIL	10	1	2.0	1	0.07 - 0.7
NOT CONTAMINATED SITES:							
1	RI WOOD RIVER JUNCTION CARROLL PRODUCTS, INC.	SOIL	23	0	ND	0	0.01 - 0.33
5	IL ATLANTA HOPKINS AGRI. CHEM. CO.	SOIL	30	0	ND	0	0.01 - 0.3
	IL QUINCY MOORMAN MANUFACTURING CO.	SOIL	38	0	ND	0	0.01 - 0.28
	MN INVER GROVE FARMERS UNION CENTRAL EXCHANGE	SOIL	23	0	ND	0	0.02 - 0.37
	OH MARYSVILLE O M SCOTT & SONS CO.	SOIL	29	0	ND	0	0.02 - 0.95
		WATER	10	0	ND	0	0.01-0.152 (PPT)

A SOIL/SEDIMENT LEVELS BASED ON DRY WEIGHT; BIOLOGICAL TISSUE LEVELS BASED ON WET WEIGHT

B CONTAMINATION DEFINED AS CONCENTRATION GREATER THAN OR EQUAL TO 1 PPB IN SOIL OR ABOVE DETECTABLE LEVELS IN OTHER MEDIA; SEDIMENT IS DEFINED AS SAMPLES WITH OVERLYING WATER SUPPORTING AQUATIC LIFE. SAMPLES FROM AREAS SUCH AS DRAINAGE DITCHES ARE CONSIDERED SOIL.

TABLE D-2 RESULTS OF TIER 3 ANALYSES - REGIONALLY SELECTED SITES

REGION	LOCATION DESCRIPTION:	MATRIX TYPE	# SAMPLED	# DETECTED	RANGE[A] (PPB UNLESS OTHERWISE NOTED)	# CONT[B]	DET LIMIT (PPB UNLESS OTHERWISE NOTED)
	WI MILWAUKEE ALDRICH CHEMICAL CO.	SOIL	6	0	ND	0	0.06 - 0.14
	WI RANDOLPH HOPKINS AGRI. CHEM. CO.	SOIL	33	0	ND	0	0.06 - 0.94
	WI STURTEVANT S.C. JOHNSON & SON	SOIL	19	0	ND	0	0.1 - 0.9
6	TX BEAUMONT VELSICOL CHEM. CORP.	SOIL WATER	29 2	0 0	ND ND	0 0	0.04 - 1.52 0.03 - 0.2(PPT)
	TX HOUSTON CSA, LTD.	SOIL	10	0	ND	0	0.04 - 0.51
	TX NACOGDOCHES C J MARTIN COMPANY	SOIL WATER	19 1	0 0	ND ND	0 0	0.02 - 0.5 0.1 (PPT)
7	IA GRIMMEL GOLDEN SUN FEEDS, INC.	SOIL DUST	38 2	1 0	0.15 ND	0 0	0.07 - 0.61 0.12 - 0.21
	IA MUSCATINE KENT FEEDS INC.	SOIL DUST	15 4	1 0	0.1 ND	0 0	0.1 - 0.8 0.1 - 0.2
	KS GARDEN CITY PUEBLO CHEM. & SUPPLY CO. (COLONY)	SOIL DUST	27 7	0 1	ND 0.21	0 0	0.1 - 0.84 0.1
	MO SAINT JOSEPH GILMORE CHEM. CO. (RHONE-POULENC)	SOIL	25	1	0.28	0	0.1 - 0.76
9	AZ TEMPE INDIANHEAD MFG. CO.	SOIL	12	0	ND	0	0.6 - 1.42
10	OR PORTLAND CHAS H. LILLY CO.	SOIL	22	0	ND	0	0.02 - 0.8

TABLE D-3 RESULTS OF TIER 5 ANALYSES

REGION	LOCATION DESCRIPTION:	MATRIX TYPE	# SAMPLED	# DETECTED	RANGE (PPT)[A]	DET LIMIT (PPT)
CONTAMINATED SITES:[B]						
1	ME B&A - R-O-W - GRINDSTONE	SOIL	22	18	8 - 35	1 - 68
2	NY LONG ISLAND RAILROAD - STEWART MANOR	SOIL	26	1	9	1 - 44
4	FL WEST PALM BEACH - FLORIDA CANALS	SEDIMENT	36	27	0.7 - 26.5	0.12 - 1.35
	MS CLEVELAND CO.	SOIL	20	16	0.8 - 1.7	0.42 - 1.21
	MS SCOT CO.	RICE	1	0	ND	0.6
		SOIL	20	2	0.6 - 0.7	0.22 - 1.45
5	WI PETENWELL FLOWAGE - WISCONSON RIVER	BOTTOM FEEDER-FILET	3	3	20 - 23	0.5 - 1.6
		BOTTOM FEEDER-WHOLE	4	4	25 - 47	0.7 - 1.2
		GREAT BLUE HERON	3	1	1.2	0.12 - 0.2
		GREEN HERON	1	1	0.76	0.4
		KING FISHER	2	2	7.8 - 12	0.4 - 0.7
		RACCOON FAT	3	1	1.9	0.13 - 0.4
		PREDATOR-FILET	2	2	3 - 8	0.8 - 0.9
		PREDATOR-WHOLE	2	2	9 - 37	0.5 - 0.7
6	AR DESHA CO.	PLANT TISSUE	5	0	ND	1 - 10
		SEDIMENT	3	0	ND	1 - 2
		SOIL	46	1	3	1 - 8
	LA ASSUMPTION PARISH	SOIL	24	14	0.3 - 1.1	0.28 - 0.82
	LA POINT COUPEE PARISH	SOIL	25	20	1 - 2.5	0.26 - 1.15
	LA RICHLAND PARISH	SEDIMENT	1	0	ND	0.46
		SOIL	35	9	0.3 - 0.4	0.19 - 0.39

A SOIL/SEDIMENT LEVELS BASED ON DRY WEIGHT; BIOLOGICAL TISSUE LEVELS BASED ON WET WEIGHT

B CONTAMINATION DEFINED AS DETECTABLE LEVELS

TABLE D-3 RESULTS OF TIER 5 ANALYSES

REGION	LOCATION DESCRIPTION:	MATRIX TYPE	# SAMPLED	# DETECTED	RANGE (PPT)[A]	DET LIMIT (PPT)
	TX RIO GRANDE PLAIN EXP. RANCH - KINNEY CO.	SOIL	38	12	0.2 - 3	0.09 - 0.75
		RATTLESNAKE	1	0	ND	0.1
		VEGETATION	6	0	ND	0.5 - 1.1
7	MO MARK TWAIN NATIONAL FOREST - FREDERICKTOWN	SOIL	50	21	0.3 - 124	0.17 - 0.7
9	AZ TONTO NATIONAL FOREST	SOIL	121	45	1.1 - 6623	0.06 - 33
		COYOTE FAT	1	0	ND	5.1
		COYOTE KIDNEY	1	0	ND	0.6
		COYOTE LIVER	1	0	ND	0.8
		DEER FAT	2	0	ND	5 - 6.9
		DEER KIDNEY	1	0	ND	0.2
		DEER LIVER	3	0	ND	0.3 - 0.6
		FROGS WHOLE (20)	1	0	ND	0.3
		JAVELINA FAT	3	0	ND	3 - 11
		JAVELINA KIDNEY	2	0	ND	0.2 - 0.4
		JAVELINA LIVER	3	0	ND	0.4 - 0.8
		QUAIL WHOLE	1	0	ND	0.3
		SUNFISH WHOLE	1	0	ND	0.44
		SNAKE WHOLE	3	0	ND	0.3 - 1.7
		TOAD WHOLE	1	0	ND	0.5
	CA SANTA ANA RIVER	BOTTOM FEEDER-WHOLE	7	1	4.6	0.24 - 0.68
		PREDATOR-WHOLE	2	0	ND	0.05 - 0.67
		SEDIMENT	28	1	0.6	0.14 - 0.85
10	OR SANTIAM FOREST - GATES	SEDIMENT	12	3	0.2 - 0.4	0.1 - 0.43
		SOIL	35	0	ND	0.13 - 1.05
		WHOLE SCULPIN	1	0	ND	0.3
NOT CONTAMINATED SITES:						
1	ME CMP - R-O-W - YARMOUTH	SOIL	23	0	ND	1 - 9
	VT LAKE ABENAKI - THETFORD	SEDIMENT	23	0	ND	1 - 3
		S.M. BASS-WHOLE	1	0	ND	2.6

TABLE D-3 RESULTS OF TIER 5 ANALYSES

REGION	LOCATION DESCRIPTION:	MATRIX TYPE	# SAMPLED	# DETECTED	RANGE (PPT)^A	DET LIMIT (PPT)
	VT LAKE CLARA - WHITINGHAM	CHAIN PICKERAL FIL	1	0	ND	0.6
		SOIL	15	0	ND	1
		SEDIMENT	8	0	ND	1 - 3
		WHITESUCKER FILLET	1	0	ND	0.7
		WHITESUCKER WHOLE	1	0	ND	0.4
3	VA KING-QUEEN CO.	SEDIMENT	3	0	ND	2
		SOIL	39	0	ND	1 - 2
		TREE BRANCHES&LEAV	4	0	ND	1.2 - 1.5
	VA MATTHEWS CO.	SOIL	36	0	ND	1 - 5
		TREE BRANCHES&LEAV	2	0	ND	0.9 - 1
4	AL ESCAMBIA EXP. FOREST - BREWTON	SOIL	20	0	ND	0.06 - 0.47
		SEDIMENT	1	0	ND	0.46
	MS BOYLE CO.	SOIL	22	0	ND	1 - 2
6	LA MADISON PARISH	SOIL	24	0	ND	0.11 - 0.88
	NM NMSU EXP. RANCH - DONA ANA CO.	SOIL	38	0	ND	0.3 - 4
		VEGETATION	9	0	ND	0.5 - 1.1
	OK TILLMAN CO.	SOIL	24	0	ND	0.2 - 4
9	CA N. CALIFORNIA RICE FIELDS	SOIL	4	0	ND	1 - 2
		SEDIMENT	20	0	ND	1 - 3
		BOTTOM FEEDER-WHOLE	2	0	ND	0.5 - 1.6
		PREDATOR-WHOLE	4	0	ND	0.9 - 2.3

TABLE D-4 RESULTS OF TIER 6 ANALYSES - STATISTICALLY SELECTED SITES

REGION	LOCATION DESCRIPTION:			MATRIX TYPE	# SAMPLED	# DETECTED	RANGE[A] (PPB UNLESS OTHERWISE NOTED)	# CONT[B]	DET LIMIT (PPB UNLESS OTHERWISE NOTED)
CONTAMINATED SITES:[B]									
2	NJ	SOMERSET	W.A. CLEARY	SOIL	31	1	34.7[C]	1	0.02 - 0.17
				SEDIMENT	1	0	ND	0	0.08
6	TX	PORT NECHES	CHEM ALL, INC. (RIVERSIDE CHEMICALS)	SOIL	32	9	0.1 - 1.4	2	0.028 - 0.37
NOT CONTAMINATED SITES:									
2	NJ	FORDS	TENNECO, INC. (NUODEX, INC.)	SOIL	27	0	ND	0	0.034 - 1
				SEDIMENT	2	0	ND	0	15 - 22 (PPT)
	NJ	TRENTON	CUSTOM PROCESSING	SOIL	13	0	ND	0	0.05 - 0.1
	NJ	HAWTHORNE	MERCK (CALGON)	SOIL	15	0	ND	0	0.03 - 0.65
3	PA	LOCK HAVEN	AMERICAN COLOR & CHEM.	SOIL	10	0	ND	0	0.014 - 0.94
				SEDIMENT	4	0	ND	0	0.04 - 0.12
				WATER	2	0	ND	0	0.002 - 0.004
				PRODUCT	1	0	ND	0	0.06
	PA	PHILEDELPHIA	ROHM & HAAS	SOIL	18	0	ND	0	0.0072 - 0.2
4	MS	VICKSBURG	VERTAC INC.	SOIL	23	0	ND	0	0.02 - 0.97
				SEDIMENT	4	0	ND	0	1 - 3.1 (PPT)
	NC	RALEIGH	MALLINCKRODT	SOIL	30	0	ND	0	0.028 - 0.69
				SOIL	6	2	1.0 - 3.6 (PPT)	0	0.23 - 0.99(PPT)

A SOIL/SEDIMENT LEVELS BASED ON DRY WEIGHT

B CONTAMINATION DEFINED AS CONCENTRATION GREATER THAN OR EQUAL TO 1 PPB IN SOIL OR ABOVE DETECTABLE LEVELS IN OTHER MEDIA; SEDIMENT IS DEFINED AS SAMPLES WITH OVERLYING WATER SUPPORTING AQUATIC LIFE. SAMPLES FROM AREAS SUCH AS DRAINAGE DITCHES ARE CONSIDERED SOIL.

C CONCENTRATION LEVEL UNCERTAIN - MAY BE HIGH BY 20%

TABLE D-4 RESULTS OF TIER 6 ANALYSES - STATISTICALLY SELECTED SITES

REGION	LOCATION DESCRIPTION:			MATRIX TYPE	# SAMPLED	# DETECTED	RANGE[A] (PPB UNLESS OTHERWISE NOTED)	# CONT[B]	DET LIMIT (PPB UNLESS OTHERWISE NOTED)
	SC	CHARLESTON HGTS.	MOBIL CORP.	SOIL	43	0	ND	0	0.1 - 0.3
5	IN	LAFAYETTE	ELI LILLY COMPANY	SOIL	41	0	ND	0	0.02 - 0.91
				WATER	4	0	ND	0	0.1 (PPT)
6	AR	HELENA	VERTAC, INC.	SOIL	46	0	ND	0	0.03 - 0.33
	TX	PASEDENA	VELSICOL	SOIL	11	0	ND	0	0.014 - 0.034
8	MT	BILLINGS	TRANSBAS	SOIL	21	0	ND	0	0.02 - 0.52
				WATER	3	0	ND	0	0.002- 0.01(PPT)
				SOIL	10	2	47.8 - 98.7(PPT)	0	0.18 - 1.02(PPT)
10	WA	TACOMA	REICHOLD CHEMICAL CO.	SOIL	40	3	0.05 - 0.29	0	0.05 - 0.8

TABLE D-5 RESULTS OF TIER 6 ANALYSES - REGIONALLY SELECTED SITES

REGION	LOCATION DESCRIPTION:	MATRIX TYPE	# SAMPLED	# DETECTED	RANGE[A] (PPB UNLESS OTHERWISE NOTED)	# CONT[B]	DET LIMIT (PPB UNLESS OTHERWISE NOTED)
CONTAMINATED[A] SITES:							
9	NV HENDERSON STAUFFER CHEM.						
		SOIL	37	1	1	1	0.05 - 0.29
		WATER	7	4	0.07 - 0.11 (PPT)	4	0.005 -0.02(PPT)
		AQUEOUS LIQUID	4	0	ND	0	0.002 - 0.005
NOT CONTAMINATED SITES:							
5	IN TERRE HAUTE INT. MINERALS & CHEMICAL CORP.						
		SOIL	42	0	ND	0	0.01 - 0.49
		WATER	5	0	ND	0	0.01 (PPT)
9	CA IRWINDALE SPECIALITY ORGANICS						
		SOIL	20	0	ND	0	0.04 - 0.36

A SOIL/SEDIMENT LEVELS BASED ON DRY WEIGHT

B CONTAMINATION DEFINED AS CONCENTRATION GREATER THAN OR EQUAL TO 1 PPB IN SOIL OR ABOVE DETECTABLE LEVELS IN OTHER MEDIA; SEDIMENT IS DEFINED AS SAMPLES WITH OVERLYING WATER SUPPORTING AQUATIC LIFE. SAMPLES FROM AREAS SUCH AS DRAINAGE DITCHES ARE CONSIDERED SOIL.

TABLE D-6 RESULTS OF ANALYSES OF TIER 7 URBAN SOILS

REGION	LOCATION DESCRIPTION[A] :	NO. SAMPLES	LEVELS DETECTED (PPT)[B]	DETECTION LIMIT (PPT)
CONTAMINATED LOCATIONS[C] :				
3	D.C., WASHINGTON	3	3.0 2.0 4.0	0.40 - 2.0
	PA, PITTSBURGH	2	5.0 2.0	1.0 - 4.0
5	IN, EVANSVILLE	1	1.3	NOT AVAILABLE
	IN, GARY	2	0.5 4.1	NOT AVAILABLE
6	LA, LAKE CHARLES	1	0.2	NOT AVAILABLE
9	CA, SAN FRANCISCO	1	2.0	1.0
10	WA, TACOMA	7	0.4 0.5 0.6 0.8 1.9 8.7 11.2	NOT AVAILABLE
	TOTAL	17		
NOT DETECTED LOCATIONS:				
1	CT, HARTFORD	8	ND	1.0 - 10.0
	MA, FITCHBURG	6	ND	1.0 - 10.0
	MA, PITTSFIELD	9	ND	1.0 - 4.0
3	PA, PITTSBURGH	22	ND	1.0 - 9.0
	PA, READING	7	ND	1.0 - 4.0
	VA, NEWPORT NEWS	11	ND	1.0 - 4.0
	D.C., WASHINGTON	16	ND	0.4 - 17.0
4	AL, GADSDEN	8	ND	1.0 - 3.0
	GA, MACON	7	ND	1.0 - 2.0
	NC, DURHAM	12	ND	0.5 - 5.5
	SC, GREENVILLE	7	ND	0.7 - 1.8
5	IL, SPRINGFIELD	11	ND	1.0 - 9.0
	IN, EVANSVILLE	2	ND	0.2 - 0.34
	IN, GARY	12	ND	0.27 - 1.13
6	AR, PINE BLUFF	10	ND	0.2 - 3.0
	LA, LAKE CHARLES	8	ND	0.07 - 0.53
7	IA, DES MOINES	14	ND	0.5 - 3.0
9	CA, SAN FRANCISCO	27	ND	1.0 - 8.0
10	WA, TACOMA	7	ND	0.33 - 0.98
	TOTAL	204		

[A] SAMPLING WAS CONDUCTED IN THE SMSAS FOR THESE CITIES
[B] SOIL LEVELS BASED ON DRY WEIGHT
[C] CONTAMINATION DEFINED AS DETECTABLE LEVELS

TABLE D-7 RESULTS OF ANALYSES OF TIER 7 RURAL SOILS

REGION	LOCATION DESCRIPTION:	LEVEL DETECTED(PPT)[A]	DETECTION LIMIT(PPT)
3	PA BRADFORD COUNTY	ND	1.00
	PA MONROE COUNTY	ND	1.00
	VA WASHINGTON COUNTY	ND	4.00
4	AL LAUDERDALE COUNTY	ND	1.00
	FL FLAGLER COUNTY	ND	1.00
	FL ORANGE COUNTY	ND ND	2.00 2.00
	GA WHITFIELD COUNTY	ND	1.00
	KY BRECKINRIDGE COUNTY	ND	3.00
	KY HARDIN COUNTY	ND	0.90
	KY WASHINGTON COUNTY	ND	0.80
	MS COAHOMA COUNTY	ND ND	1.00 2.00
	MS PERRY COUNTY	ND	0.90
	MS TATE COUNTY	ND	3.00
	NC PERQUIMANS COUNTY	ND	2.00
	TN ROBERTSON COUNTY	ND	1.00
5	IL CHRISTIAN COUNTY	ND	1.00
	IL CLAY COUNTY	ND ND	1.00 1.00
	IL HENRY COUNTY	ND	1.00
	IL IROQUOIS COUNTY	ND	0.31
	IL LOGAN COUNTY	ND	1.00
	IL MCDONOUGH COUNTY	ND	1.00
	IL SHELBY COUNTY	ND	1.00
	IN WARREN COUNTY	ND	0.36

[A] SOIL LEVELS BASED ON DRY WEIGHT

TABLE D-7 RESULTS OF ANALYSES OF TIER 7 RURAL SOILS

REGION	LOCATION DESCRIPTION:	LEVEL DETECTED(PPT)[A]	DETECTION LIMIT(PPT)
	IN WAYNE COUNTY	ND	0.36
	IN WHITLEY COUNTY	ND	0.59
	MI CALHOUN COUNTY	ND	2.00
	MI PRESQUE ISLE COUNTY	ND	0.45
	MN CARVER COUNTY	ND	0.12
	MN CHISAGO COUNTY	ND	0.37
	MN HENNEPIN COUNTY	ND	0.18
	MN KANABEC COUNTY	ND	0.25
	MN POLK COUNTY	ND	0.24
	MN REDWOOD COUNTY	ND	0.18
	MN WATONWAN COUNTY	ND ND	0.34 0.21
	OH PREBLE COUNTY	ND	0.29
	OH SANDUSKY COUNTY	ND	0.42
	OH SHELBY COUNTY	ND ND	0.30 0.36
	WI CHIPPEWA COUNTY	ND	0.39
	WI ST. CROIX COUNTY	ND	0.34
	WI WAUSHARA COUNTY	ND ND	0.36 0.12
6	AR DESHA COUNTY	ND	0.70
	AR GREENE COUNTY	ND	0.80
	AR LAWRENCE COUNTY	ND	0.20
	AR MADISON COUNTY	ND	0.40
	LA CALCASIEU PARISH	ND	0.38
	OK BEAVER COUNTY	ND	0.28
	OK COTTON COUNTY	ND	0.06
	OK LEFLORE COUNTY	ND	0.41

TABLE D-7 RESULTS OF ANALYSES OF TIER 7 RURAL SOILS

REGION	LOCATION DESCRIPTION:	LEVEL DETECTED(PPT)[A]	DETECTION LIMIT(PPT)
	OK OSAGE COUNTY	ND	0.25
		ND	0.19
	OK WOODS COUNTY	ND	0.34
	TX ARMSTRONG COUNTY	ND	0.83
		ND	0.17
	TX CAMERON COUNTY	ND	0.12
		ND	0.27
	TX CASTRO COUNTY	ND	0.11
		ND	0.28
	TX DUVAL COUNTY	ND	0.13
		ND	0.29
	TX ELLIS COUNTY	ND	1.04
		ND	0.24
	TX FRIO COUNTY	ND	0.25
		ND	0.12
	TX HALE COUNTY	ND	0.33
		ND	0.32
	TX HALL COUNTY	ND	0.16
		ND	0.18
		ND	0.33
	TX KERR COUNTY	ND	0.30
		ND	0.27
	TX KINNEY COUNTY	ND	1.29
		ND	0.58
	TX LAMB COUNTY	ND	0.99
		ND	0.27
	TX NUECES COUNTY	ND	0.08
		ND	0.10
	TX RUNNELS COUNTY	ND	0.34
		ND	0.33
	TX WICHITA COUNTY	ND	0.19
		ND	0.25
7	IA ADAIR COUNTY	ND	2.00
	IA FLOYD COUNTY	ND	0.28
		ND	1.24

TABLE D-7 RESULTS OF ANALYSES OF TIER 7 RURAL SOILS

REGION	LOCATION DESCRIPTION:	LEVEL DETECTED(PPT)[A]	DETECTION LIMIT(PPT)
	IA JASPER COUNTY	ND	1.00
	IA TAYLOR COUNTY	ND	2.00
	IA WARREN COUNTY	ND	1.00
	KS CHEYENNE COUNTY	ND	0.06
	KS GOVE COUNTY	ND	0.17
	KS MARSHALL COUNTY	ND	1.00
	KS MCPHERSON COUNTY	ND	0.46
	KS MEADE COUNTY	ND	0.12
	KS RAWLINS COUNTY	ND	0.14
	KS RICE COUNTY	ND	0.15
	KS RUSSELL COUNTY	ND	0.18
	KS SUMNER COUNTY	ND ND	0.17 0.54
	KS WALLACE COUNTY	ND	0.14
	MO ANDREW COUNTY	ND	0.70
	MO BARTON COUNTY	ND ND	0.07 0.17
	MO GREENE COUNTY	ND	0.71
	MO HOLT COUNTY	ND	1.00
	NE BOX BUTTE COUNTY	ND ND	0.20 0.12
	NE BUFFALO COUNTY	ND	0.31
	NE BURT COUNTY	ND ND	0.51 0.48
	NE FILLMORE COUNTY	ND	0.15
	NE KNOX COUNTY	ND	0.17
	NE RICHARDSON COUNTY	ND ND	1.00 1.00

TABLE D-7 RESULTS OF ANALYSES OF TIER 7 RURAL SOILS

REGION	LOCATION DESCRIPTION:	LEVEL DETECTED(PPT)[A]	DETECTION LIMIT(PPT)
8	CO ARCHULETA COUNTY	ND	1.00
	CO ELBERT COUNTY	ND	1.00
	CO GILPIN COUNTY	ND	1.00
	CO MONTROSE COUNTY	ND	1.00
	CO PHILLIPS COUNTY	ND	1.00
	MT FERGUS COUNTY	ND	0.21
	MT GALLATIN COUNTY	ND	0.14
	MT HILL COUNTY	ND	0.47
	MT JEFFERSON COUNTY	ND	0.54
	MT LIBERTY COUNTY	ND	0.25
	MT MADISON COUNTY	ND	0.19
	MT PARK COUNTY	ND	0.20
	ND BURLEIGH COUNTY	ND	0.35
	ND KIDDER COUNTY	ND	0.31
	ND LOGAN COUNTY	ND	0.25
	ND MCLEAN COUNTY	ND	0.15
	ND MORTON COUNTY	ND	0.37
	SD BRULE COUNTY	ND	0.26
	SD CHARLES MIX COUNTY	ND	0.40
	SD CLAY COUNTY	ND	0.24
	SD HAAKON COUNTY	ND	0.33
	SD MARSHALL COUNTY	ND	0.90
	SD STANLEY COUNTY	ND	0.12
	SD TODD COUNTY	ND	0.45
	SD TRIPP COUNTY	ND	0.18
	SD TURNER COUNTY	ND	0.38
	UT MILLARD COUNTY	ND	0.11

TABLE D-7 RESULTS OF ANALYSES OF TIER 7 RURAL SOILS

REGION	LOCATION DESCRIPTION:	LEVEL DETECTED(PPT)[A]	DETECTION LIMIT(PPT)
	WY CAMPBELL COUNTY	ND	0.93
	WY CROOK COUNTY	ND	0.07
	WY SHERIDAN COUNTY	ND	0.17
	WY WASHAKIE COUNTY	ND	0.60
	WY WESTON COUNTY	ND	0.07
9	CA GLENN COUNTY	ND	0.19
	CA MENDOCINO COUNTY	ND	0.20
	CA SAN JOAQUIN COUNTY	ND ND	0.14 0.22
	CA SANTA BARBARA COUNTY	ND ND	0.08 0.07
	NV ELKO COUNTY	ND	0.33
	NV NYE COUNTY	ND	1.00
10	ID CASSIA COUNTY	ND	0.19
	ID GOODING COUNTY	ND	0.88
	ID TETON COUNTY	ND	0.27
	OR LINN COUNTY	0.50	NOT AVAILABLE
	OR MALHEUR COUNTY	ND	0.29
	OR MARION COUNTY	ND	0.24
	OR MORROW COUNTY	ND	0.16 0.40
	WA ADAMS COUNTY	ND	0.33
	WA DOUGLAS COUNTY	ND	0.08
	WA SKAGIT COUNTY	ND	0.34
	WA STEVENS COUNTY	ND	0.47

TABLE D-8 RESULTS OF ANALYSES OF TIER 7 FISH - STATISTICALLY SELECTED SITES

REGION	LOCATION DESCRIPTION:	TYPE OF FISH	CUT OF SAMPLE	# DETECTED	VALUE (PPT)[A]	DET LIMIT (PPT)[B]
CONTAMINATED SITES:[C]						
1	ME ANDROSCOGGIN RIVER - BRUNSWICK	BOTTOM FEEDER	WHOLE FISH	1	19	1
		BOTTOM FEEDER	FILET	1	11	0.6
3	MD SUSQUEHANNA RIVER - CONOWINGO	BOTTOM FEEDER	WHOLE FISH	1	1.2	0.8
		BOTTOM FEEDER	FILET	1	0.5	0.1
	PA SCHUYLKILL RIVER - PHILADELPHIA	BOTTOM FEEDER	WHOLE FISH	2	1.2	0.1
		BOTTOM FEEDER	FILET	0	ND	0.7
		PREDATOR	WHOLE FISH	1	1.9	0.2
		PREDATOR	FILET	0	ND	0.5
4	MS YAZOO RIVER - REDWOOD	PREDATOR	WHOLE FISH	2	3.2	1.1
		PREDATOR	FILET	0	ND	1.2
5	IN WABASH RIVER - NEW HARMONY	BOTTOM FEEDER	WHOLE FISH	1	2	0.3
		BOTTOM FEEDER	FILET	0	ND	0.9
		PREDATOR	WHOLE FISH	0	ND	0.9
	MI MUSKEGON RIVER - BRIDGETON	BOTTOM FEEDER	WHOLE FISH	1	2.8	0.1
		BOTTOM FEEDER	FILET	0	ND	0.6
		PREDATOR	WHOLE FISH	1	4.3	0.1
		PREDATOR	FILET	0	ND	0.4
	MN RAINY RIVER - LONG SAULT	BOTTOM FEEDER	WHOLE FISH	1	19	1.2
		PREDATOR	WHOLE FISH	1	12	2
	OH GREAT MIAMI RIVER - NEW BALTIMORE	BOTTOM FEEDER	WHOLE FISH	0	ND	4.6
		PREDATOR	WHOLE FISH	1	1.2	0.08

[A] IF MORE THAN ONE VALUE REPORTED FOR ONE TYPE OF SAMPLE, THE HIGHEST VALUE IS SHOWN

[B] BIOLOGICAL TISSUE LEVELS BASED ON WET WEIGHT

[C] CONTAMINATION DEFINED AS DETECTABLE LEVELS

TABLE D-8 RESULTS OF ANALYSES OF TIER 7 FISH - STATISTICALLY SELECTED SITES

REGION	LOCATION DESCRIPTION:	TYPE OF FISH	CUT OF SAMPLE	# DETECTED	VALUE (PPT)[A]	DET LIMIT (PPT)[B]
	OH LITTLE MIAMI RIVER - MILFORD	BOTTOM FEEDER	WHOLE FISH	1	1.2	0.18
	WI NEMADJI RIVER - SOUTH SUPERIOR	BOTTOM FEEDER	WHOLE FISH	1	4	0.2
		BOTTOM FEEDER	FILET	1	0.9	0.4
		PREDATOR	WHOLE FISH	1	1.5	0.6
6	AR MISSISSIPPI RIVER - ARKANSAS CITY	BOTTOM FEEDER	WHOLE FISH	1	3.7	0.4
		PREDATOR	WHOLE FISH	1	2.4	0.96
	AR RED RIVER - INDEX	BOTTOM FEEDER	WHOLE FISH	1	6	0.8
		BOTTOM FEEDER	FILET	1	1.9	0.3
	LA BEOUF RIVER - FT. NECESSITY	BOTTOM FEEDER	WHOLE FISH	1	7	0.2
		BOTTOM FEEDER	FILET	0	ND	0.3
		PREDATOR	WHOLE FISH	1	1.1	0.4
		PREDATOR	FILET	0	ND	0.6
	OK WASHITA RIVER - DURWOOD	BOTTOM FEEDER	WHOLE FISH	1	1.3	0.32
		BOTTOM FEEDER	FILET	0	ND	0.39
		PREDATOR	WHOLE FISH	0	ND	0.38
		PREDATOR	FILET	0	ND	0.34
7	NE PLATTE RIVER - LOUISVILLE	BOTTOM FEEDER	WHOLE FISH	1	2	0.4
		BOTTOM FEEDER	FILET	0	ND	1.4
9	CA OWENS RIVER - BIG PINE	BOTTOM FEEDER	WHOLE FISH	1	1.2	0.8
		BOTTOM FEEDER	FILET	0	ND	1.3
		PREDATOR	WHOLE FISH	0	ND	0.7
10	OR WILLAMETTE RIVER - PORTLAND	BOTTOM FEEDER	WHOLE FISH	2	4.5	1.1
		BOTTOM FEEDER	FILET	1	1.5	0.73
NOT CONTAMINATED SITES:						
1	CT CONNECTICUT RIVER - THOMPSONVILLE	BOTTOM FEEDER	WHOLE FISH	0	ND	3.8
	ME NARRAGUAGUS RIVER - CHERRYFIELD	BOTTOM FEEDER	WHOLE FISH	0	ND	1

TABLE D-8 RESULTS OF ANALYSES OF TIER 7 FISH - STATISTICALLY SELECTED SITES

REGION	LOCATION DESCRIPTION:	TYPE OF FISH	CUT OF SAMPLE	# DETECTED	VALUE[A] (PPT)	DET LIMIT[B] (PPT)
2	NJ RARITAN RIVER - QUEENS BRIDGE	PREDATOR	WHOLE FISH	0	ND	1.6
	NY NISSEQUOGUE RIVER - SMITHTOWN	PREDATOR	WHOLE FISH	0	ND	0.2
	NY RICHELIEU RIVER - ROUSES POINT	PREDATOR	WHOLE FISH	0	ND	2.9
	NY TONAWANDA CREEK - BATAVIA	BOTTOM FEEDER	WHOLE FISH	0	ND	0.3
3	VA APPOMATTOX RIVER - MATOACA	BOTTOM FEEDER	WHOLE FISH	0	ND	0.8
	VA PAMUNKEY RIVER - HANOVER	PREDATOR	WHOLE FISH	0	ND	1.7
4	AL ALABAMA RIVER - MONTGOMERY	BOTTOM FEEDER	WHOLE FISH	0	ND	0.6
	AL CHATTAHOOCHEE RIVER - COLUMBUS	BOTTOM FEEDER	WHOLE FISH	0	ND	0.4
	FL CHIPOLA RIVER - ALTHA	BOTTOM FEEDER	WHOLE FISH	0	ND	1.2
	FL ECONFINA CREEK - BENNET	BOTTOM FEEDER	WHOLE FISH	0	ND	0.4
	FL FISHEATING CREEK - PALMDALE	BOTTOM FEEDER	WHOLE FISH	0	ND	0.2
	FL MAIN CANAL - VERO BEACH	BOTTOM FEEDER	WHOLE FISH	0	ND	0.4
	FL ST. MARYS RIVER - McCLENNY	BOTTOM FEEDER	WHOLE FISH	0	ND	1.1
	KY BIG SANDY RIVER - LOUISA	BOTTOM FEEDER	WHOLE FISH	0	ND	3.2

TABLE D-8 RESULTS OF ANALYSES OF TIER 7 FISH - STATISTICALLY SELECTED SITES

REGION	LOCATION DESCRIPTION:	TYPE OF FISH	CUT OF SAMPLE	# DETECTED	VALUE[A] (PPT)	DET LIMIT[B] (PPT)
	MS CYPRESS CREEK - JANICE	BOTTOM FEEDER	WHOLE FISH	0	ND	0.9
	MS ESCATAWPA RIVER - AGRICOLA	BOTTOM FEEDER	WHOLE FISH	0	ND	0.4
	NC CATALOOCHEE CREEK - CATALOOCHEE	BOTTOM FEEDER	WHOLE FISH	0	ND	0.6
	SC COOSAWHATCHIE RIVER - HAMPTON	PREDATOR	WHOLE FISH	0	ND	1
	TN BUFFALO RIVER - FLAT WOODS	PREDATOR	WHOLE FISH	0	ND	0.69
	TN CLINCH RIVER - MELTON HILL DAM	BOTTOM FEEDER	WHOLE FISH	0	ND	2.1
5	MI MANISTEE RIVER - MANISTEE	BOTTOM FEEDER	WHOLE FISH	0	ND	1.3
	MI RIFLE RIVER - STERLING	BOTTOM FEEDER	WHOLE FISH	0	ND	2.2
	MI ST. MARYS RIVER - SAULT STE MARIE	BOTTOM FEEDER	WHOLE FISH	0	ND	2.5
	MI TAHQUAMENON RIVER - TAHQUAMENON PARADISE	BOTTOM FEEDER PREDATOR	WHOLE FISH WHOLE FISH	0 0	ND ND	0.1 0.2
	MI WASHINGTON CREEK - ISLE ROYALE	BOTTOM FEEDER	WHOLE FISH	0	ND	0.5
	MN MINNESOTA RIVER - JORDON	BOTTOM FEEDER	WHOLE FISH	0	ND	1.1
6	AR NORTH SYLAMORE CREEK - FIFTY SIX	BOTTOM FEEDER	WHOLE FISH	0	ND	1.1
	AR SULPHUR RIVER - TEXARKANA	BOTTOM FEEDER	WHOLE FISH	0	ND	1.1

TABLE D-8 RESULTS OF ANALYSES OF TIER 7 FISH - STATISTICALLY SELECTED SITES

REGION	LOCATION DESCRIPTION:	TYPE OF FISH	CUT OF SAMPLE	# DETECTED	VALUE[A] (PPT)	DET LIMIT[B] (PPT)
	LA TANGIPAHOA RIVER - ROBERT	BOTTOM FEEDER	WHOLE FISH	0	ND	0.5
	NM CANADIAN RIVER - NM-TEX STATE LINE	BOTTOM FEEDER	WHOLE FISH	0	ND	0.7
	NM RIO MORA RIVER - TERERRO	PREDATOR	WHOLE FISH	0	ND	0.2
	OK KIAMICHI RIVER - BIG CEDAR	BOTTOM FEEDER	WHOLE FISH	0	ND	0.5
	OK RED RIVER - DENISON DAM	BOTTOM FEEDER	WHOLE FISH	0	ND	1.8
	TX BRAZOS RIVER - HIGHBANK	BOTTOM FEEDER	WHOLE FISH	0	ND	0.7
	TX COLORADO RIVER - SILVER	BOTTOM FEEDER	WHOLE FISH	0	ND	0.7
	TX GUADALUPE RIVER - VICTORIA	BOTTOM FEEDER	WHOLE FISH	0	ND	1.1
	TX LAVACA RIVER - EDNA	BOTTOM FEEDER	WHOLE FISH	0	ND	1.6
	TX LITTLE RIVER - CAMERON	BOTTOM FEEDER	FILET	0	ND	0.52
	TX SOUTH FORK ROCKY CREEK - BRIGGS	BOTTOM FEEDER	WHOLE FISH	0	ND	0.8
	TX TRINITY RIVER - ROMAYOR	BOTTOM FEEDER	WHOLE FISH	0	ND	1
7	IA IOWA RIVER - WAPELLO	BOTTOM FEEDER	WHOLE FISH	0	ND	0.35
	IA NISHNABOTNA RIVER - HAMBURG	BOTTOM FEEDER	WHOLE FISH	0	ND	1.2

TABLE D-8 RESULTS OF ANALYSES OF TIER 7 FISH - STATISTICALLY SELECTED SITES

REGION	LOCATION DESCRIPTION:	TYPE OF FISH	CUT OF SAMPLE	# DETECTED	VALUE[A] (PPT)	DET[B] LIMIT (PPT)
	MO OSAGE RIVER - SCHELL CITY	BOTTOM FEEDER	WHOLE FISH	0	ND	0.8
		BOTTOM FEEDER	FILET	0	ND	0.2
		PREDATOR	WHOLE FISH	0	ND	0.1
		PREDATOR	FILET	0	ND	0.1
	NE MISSOURI RIVER - OMAHA	BOTTOM FEEDER	WHOLE FISH	0	ND	0.6
8	CO COLORADO RIVER - COLORADO - UTAH BORDER	BOTTOM FEEDER	WHOLE FISH	0	ND	0.4
	MT FLATHEAD RIVER - COLUMBIA FALLS	BOTTOM FEEDER	WHOLE FISH	0	ND	0.6
	MT MISSOURI RIVER - FORT BENTON	BOTTOM FEEDER	WHOLE FISH	0	ND	1.6
	MT MISSOURI RIVER - VIRGELLE	BOTTOM FEEDER	WHOLE FISH	0	ND	1
	MT POWDER RIVER - LOCATE	BOTTOM FEEDER	WHOLE FISH	0	ND	0.7
	MT ROCK CREEK - HORSE CREEK	BOTTOM FEEDER	WHOLE FISH	0	ND	0.2
	MT YELLOWSTONE RIVER - BILLINGS	BOTTOM FEEDER	WHOLE FISH	0	ND	1.4
	ND LITTLE MISSOURI RIVER - WATFORD CITY	BOTTOM FEEDER	WHOLE FISH	0	ND	0.9
	SD CASTLE CREEK - HILL CITY	PREDATOR	WHOLE FISH	0	ND	0.3
	UT DELORES RIVER - CISCO	BOTTOM FEEDER	WHOLE FISH	0	ND	0.7
	WY CACHE CREEK - JACKSON	PREDATOR	WHOLE FISH	0	ND	1.2

TABLE D-8 RESULTS OF ANALYSES OF TIER 7 FISH - STATISTICALLY SELECTED SITES

REGION	LOCATION DESCRIPTION:	TYPE OF FISH	CUT OF SAMPLE	# DETECTED	VALUE (PPT)[A]	DET LIMIT (PPT)[B]
	WY NORTH PLATTE RIVER - ALCOVA	BOTTOM FEEDER	WHOLE FISH	0	ND	0.74
9	CA KLAMATH RIVER - KLAMATH GLEN	BOTTOM FEEDER	WHOLE FISH	0	ND	0.7
	CA SAN JOAQUIN RIVER - VERNALIS	PREDATOR	WHOLE FISH	0	ND	0.8
	CA SAN LUIS REY RIVER - OCEANSIDE	PREDATOR	WHOLE FISH	0	ND	1.3
	CA SANTA CLARA RIVER - LA-VENTURA COUNTY LINE	BOTTOM FEEDER	WHOLE FISH	0	ND	0.23
	HI HALAWA STREAM - HALAWA	BOTTOM FEEDER	WHOLE FISH	0	ND	0.6
	HI HONOLII STREAM - PAPAIKOU	BOTTOM FEEDER	WHOLE FISH	0	ND	1
	NV COLORADO RIVER - BELOW HOOVER DAM	BOTTOM FEEDER	WHOLE FISH	0	ND	0.5
	NV HUMBOLDT RIVER - CARLIN	BOTTOM FEEDER	WHOLE FISH	0	ND	0.08
10	AK SUSITNA RIVER - SUSITNA STATION	PREDATOR	WHOLE FISH	0	ND	0.8
	ID SNAKE RIVER - KING HILL	BOTTOM FEEDER	WHOLE FISH	0	ND	0.29
	OR COLUMBIA RIVER - WARRENDALE	BOTTOM FEEDER BOTTOM FEEDER	WHOLE FISH FILET	0 0	ND ND	0.4 0.7
	WA OKANOGAN RIVER - MALLOT	BOTTOM FEEDER	WHOLE FISH	0	ND	1.1

TABLE D-8 RESULTS OF ANALYSES OF TIER 7 FISH - STATISTICALLY SELECTED SITES

REGION	LOCATION DESCRIPTION:	TYPE OF FISH	CUT OF SAMPLE	# DETECTED	VALUE (PPT)[A]	DET LIMIT (PPT)[B]
	WA PUYALLUP RIVER - PUYALLUP	PREDATOR	WHOLE FISH	0	ND	0.4
	WA SNOHOMISH RIVER - MONROE	BOTTOM FEEDER	WHOLE FISH	0	ND	0.7
	WA WILLAPA RIVER - WILLAPA	BOTTOM FEEDER	WHOLE FISH	0	ND	0.3

TABLE D-9 RESULTS OF ANALYSES OF TIER 7 FISH - REGIONALLY SELECTED SITES

REGION	LOCATION DESCRIPTION:	TYPE OF FISH	CUT OF SAMPLE	# DETECTED	VALUE (PPT)[A]	DET LIMIT (PPT)[B]
CONTAMINATED SITES:[C]						
1	CT QUINIPIAC RIVER - NORTH HAVEN					
		BOTTOM FEEDER	WHOLE FISH	1	0.9	0.3
		BOTTOM FEEDER	FILET	0	ND	0.66
	MA BLACKSTONE RIVER - MILLVILLE					
		BOTTOM FEEDER	WHOLE FISH	1	1.1	0.05
		BOTTOM FEEDER	FILET	1	0.4	0.13
		PREDATOR	WHOLE FISH	1	2.4	0.1
		PREDATOR	FILET	0	ND	0.76
	MA MERRIMACK RIVER - TYNGS ISLAND					
		BOTTOM FEEDER	WHOLE FISH	1	1.2	0.24
	MA NASHUA RIVER - PEPPERELL					
		BOTTOM FEEDER	WHOLE FISH	1	3.3	0.5
		BOTTOM FEEDER	FILET	0	ND	0.7
		PREDATOR	WHOLE FISH	1	3.5	0.3
		PREDATOR	FILET	0	ND	1.1
	ME ANDROSCOGGIN RIVER - LEWISTON					
		BOTTOM FEEDER	WHOLE FISH	1	29	0.32
		BOTTOM FEEDER	FILET	1	4.6	0.43
		PREDATOR	WHOLE FISH	1	24	0.5
		PREDATOR	FILET	1	4.5	0.47
	ME KENNEBEC RIVER - SIDNEY					
		BOTTOM FEEDER	WHOLE FISH	1	11.4	0.02
		BOTTOM FEEDER	FILET	1	1.2	0.4
		PREDATOR	WHOLE FISH	1	20.3	0.4
	ME PENOBSCOT RIVER - EDDINGTON					
		BOTTOM FEEDER	WHOLE FISH	1	7.6	0.2
		BOTTOM FEEDER	FILET	1	2.6	0.45
		PREDATOR	WHOLE FISH	1	4.6	0.5
	VT CONNECTICUT RIVER - NEWBURY					
		BOTTOM FEEDER	WHOLE FISH	1	1.6	0.11
		BOTTOM FEEDER	FILET	0	ND	0.6
		PREDATOR	WHOLE FISH	0	ND	1.4
		PREDATOR	FILET	0	ND	0.4

[A] IF MORE THAN ONE VALUE REPORTED FOR ONE TYPE OF SAMPLE, THE HIGHEST VALUE IS SHOWN

[B] BIOLOGICAL TISSUE LEVELS BASED ON WET WEIGHT

[C] CONTAMINATION DEFINED AS DETECTABLE LEVELS

TABLE D-9 RESULTS OF ANALYSES OF TIER 7 FISH - REGIONALLY SELECTED SITES

					A	B
REGION	LOCATION DESCRIPTION:	TYPE OF FISH	CUT OF SAMPLE	# DETECTED	VALUE (PPT)	DET LIMIT (PPT)
2	NJ PASSAIC RIVER - PATERSON	BOTTOM FEEDER	WHOLE FISH	1	1.7	3.8
		BOTTOM FEEDER	FILET	1	0.9	0.6
	NY HUDSON RIVER - PEEKSKILL	BOTTOM FEEDER	WHOLE FISH	1	2.7	0.1
		PREDATOR	WHOLE FISH	1	1.3	0.21
		PREDATOR	FILET	0	ND	0.2
	NY HUDSON RIVER @ GREEN ISLAND - TROY	BOTTOM FEEDER	WHOLE FISH	1	1.9	0.58
		BOTTOM FEEDER	FILET	0	ND	0.7
		PREDATOR	WHOLE FISH	1	1.2	0.75
		PREDATOR	FILET	0	ND	0.26
3	DC POTOMAC RIVER - EAST POTOMAC PARK	PREDATOR	WHOLE FISH	2	4.9	0.8
		PREDATOR	FILET	2	5	0.9
	MD POTOMAC RIVER - SHEPHERDSTOWN	PREDATOR	WHOLE FISH	2	4.8	0.5
		PREDATOR	FILET	1	2.9	0.3
	PA ALLEGHENY RIVER - NEW KENSINGTON	BOTTOM FEEDER	WHOLE FISH	1	1.7	0.44
		PREDATOR	WHOLE FISH	0	ND	1
	PA JUNIATA RIVER - NEWPORT	BOTTOM FEEDER	WHOLE FISH	1	0.7	0.1
		PREDATOR	WHOLE FISH	0	ND	1.1
		PREDATOR	FILET	0	ND	0.4
	VA JAMES RIVER - GLASGOW	BOTTOM FEEDER	WHOLE FISH	1	4.5	0.8
		BOTTOM FEEDER	FILET	0	ND	1.6
		PREDATOR	WHOLE FISH	1	1.4	0.3
		PREDATOR	FILET	0	ND	1
	VA SHENANDOAH RIVER - ROCKLAND	BOTTOM FEEDER	WHOLE FISH	1	1	1.3
		BOTTOM FEEDER	FILET	0	ND	0.4
		PREDATOR	WHOLE FISH	0	ND	0.2
	WV OHIO RIVER @ PIKE ISLAND - WHEELING	BOTTOM FEEDER	WHOLE FISH	1	1.2	0.1
		BOTTOM FEEDER	FILET	0	ND	1
		PREDATOR	WHOLE FISH	1	1.2	0.2
		PREDATOR	FILET	0	ND	0.6

TABLE D-9 RESULTS OF ANALYSES OF TIER 7 FISH - REGIONALLY SELECTED SITES

REGION	LOCATION DESCRIPTION:	TYPE OF FISH	CUT OF SAMPLE	# DETECTED[A]	VALUE (PPT)[B]	DET LIMIT (PPT)
4	AL ALABAMA RIVER - CLAIBORNE					
		BOTTOM FEEDER	WHOLE FISH	1	23	0.65
		BOTTOM FEEDER	FILET	1	2.4	0.08
		PREDATOR	WHOLE FISH	1	17	0.09
		PREDATOR	FILET	1	12	0.15
	AL COOSA RIVER - CHILDERSBURG					
		BOTTOM FEEDER	WHOLE FISH	1	15	0.1
		BOTTOM FEEDER	FILET	1	3.2	1.2
		PREDATOR	WHOLE FISH	1	13	1.4
		PREDATOR	FILET	1	6.7	0.3
	AL TENNESSEE RIVER - WATERLOO					
		BOTTOM FEEDER	WHOLE FISH	1	3.5	0.75
		BOTTOM FEEDER	FILET	1	2	0.23
		PREDATOR	WHOLE FISH	0	ND	1.5
		PREDATOR	FILET	0	ND	0.22
	GA FLINT RIVER, LAKE BLACKSHEAR - CORDELE					
		BOTTOM FEEDER	WHOLE FISH	1	1.3	0.1
		PREDATOR	FILET	1	1.1	0.08
	GA SAVANNAH RIVER - AUGUSTA					
		BOTTOM FEEDER	WHOLE FISH	1	3	0.3
		BOTTOM FEEDER	FILET	1	8.1	1.6
		PREDATOR	WHOLE FISH	1	5.1	0.1
	KY KENTUCKY RIVER - GEST					
		BOTTOM FEEDER	WHOLE FISH	1	0.8	0.23
		BOTTOM FEEDER	FILET	0	ND	0.45
		PREDATOR	WHOLE FISH	0	ND	0.31
		PREDATOR	FILET	0	ND	0.62
	KY OHIO RIVER - CANNELTON DAM					
		BOTTOM FEEDER	WHOLE FISH	1	3.9	0.24
		BOTTOM FEEDER	FILET	0	ND	1.2
		PREDATOR	WHOLE FISH	1	4.1	0.13
		PREDATOR	FILET	0	ND	2.6
	KY OHIO RIVER - MARKLAND DAM					
		BOTTOM FEEDER	WHOLE FISH	1	13	1.1
		BOTTOM FEEDER	FILET	1	6.4	0.06
		PREDATOR	WHOLE FISH	1	4.2	0.06
		PREDATOR	FILET	0	ND	0.53

TABLE D-9 RESULTS OF ANALYSES OF TIER 7 FISH - REGIONALLY SELECTED SITES

REGION	LOCATION DESCRIPTION:	TYPE OF FISH	CUT OF SAMPLE	# DETECTED	A VALUE (PPT)	B DET LIMIT (PPT)
	KY OHIO RIVER - UNIONTOWN	BOTTOM FEEDER	WHOLE FISH	1	3.4	1.6
		PREDATOR	WHOLE FISH	0	ND	0.9
	KY OHIO RIVER - WESTPOINT	BOTTOM FEEDER	WHOLE FISH	1	5.2	0.3
		PREDATOR	WHOLE FISH	1	2.1	0.4
	MS BIG BLACK RIVER - BOVINA	BOTTOM FEEDER	WHOLE FISH	1	2.2	0.1
		BOTTOM FEEDER	FILET	0	ND	0.64
		PREDATOR	WHOLE FISH	0	ND	0.4
		PREDATOR	FILET	0	ND	0.9
	MS HOMOCHITTO RIVER - ROSETTA	PREDATOR	WHOLE FISH	2	1.8	0.5
		PREDATOR	FILET	1	2.6	0.3
	MS PASCAGOULA RIVER - BENNDALE	BOTTOM FEEDER	WHOLE FISH	1	5.2	0.7
		BOTTOM FEEDER	FILET	0	ND	2.9
		PREDATOR	WHOLE FISH	1	2.7	0.2
		PREDATOR	FILET	0	ND	0.67
	NC CATAWBA RIVER - LAKE HICKORY	BOTTOM FEEDER	WHOLE FISH	1	1.5	0.21
		BOTTOM FEEDER	FILET	0	ND	0.7
		PREDATOR	WHOLE FISH	0	ND	0.4
		PREDATOR	FILET	0	ND	0.6
	SC LAKE MURRAY - PROSPERITY	BOTTOM FEEDER	WHOLE FISH	1	3.7	0.1
		BOTTOM FEEDER	FILET	1	1	0.74
		PREDATOR	WHOLE FISH	0	ND	1.4
		PREDATOR	FILET	0	ND	1.3
	SC PEE DEE RIVER - PEE DEE	BOTTOM FEEDER	WHOLE FISH	1	2.3	0.6
		BOTTOM FEEDER	FILET	1	3.9	0.1
		PREDATOR	WHOLE FISH	0	ND	0.7
		PREDATOR	FILET	0	ND	0.8
5	IL DES PLAINES RIVER - LOCKPORT	BOTTOM FEEDER	WHOLE FISH	1	12	0.6
		BOTTOM FEEDER	FILET	1	8.9	0.1

TABLE D-9 RESULTS OF ANALYSES OF TIER 7 FISH - REGIONALLY SELECTED SITES

REGION	LOCATION DESCRIPTION:	TYPE OF FISH	CUT OF SAMPLE	# DETECTED	[A] VALUE (PPT)	[B] DET LIMIT (PPT)
IL	ILLINOIS RIVER - FLORENCE					
		BOTTOM FEEDER	WHOLE FISH	1	2.7	0.5
		BOTTOM FEEDER	FILET	0	ND	0.92
		PREDATOR	WHOLE FISH	0	ND	0.69
		PREDATOR	FILET	0	ND	0.36
IL	ILLINOIS RIVER - MARSEILLES					
		BOTTOM FEEDER	WHOLE FISH	1	15	0.7
		BOTTOM FEEDER	FILET	1	7	0.3
IL	KASKASKIA RIVER - VANDALIA					
		BOTTOM FEEDER	WHOLE FISH	1	1.2	1
		BOTTOM FEEDER	FILET	0	ND	0.7
		PREDATOR	WHOLE FISH	0	ND	3
IL	MISSISSIPPI RIVER - THEBES					
		BOTTOM FEEDER	WHOLE FISH	1	5.4	0.3
		BOTTOM FEEDER	FILET	0	ND	1.6
		PREDATOR	WHOLE FISH	0	ND	1.6
IN	INDIANA HARBOR CANAL - E. CHICAGO					
		BOTTOM FEEDER	WHOLE FISH	1	8	0.1
IN	MISSISSNEWA RIVER - MATTHEWS					
		BOTTOM FEEDER	WHOLE FISH	1	1	0.1
		BOTTOM FEEDER	FILET	0	ND	1.1
		PREDATOR	WHOLE FISH	1	2	0.1
		PREDATOR	FILET	0	ND	0.8
IN	WABASH RIVER - BLACKROCK					
		BOTTOM FEEDER	WHOLE FISH	1	1.4	0.2
		BOTTOM FEEDER	FILET	0	ND	0.4
MI	CLINTON RIVER - MT. CLEMENS					
		BOTTOM FEEDER	WHOLE FISH	1	2.6	0.3
MI	FLINT RIVER, ELMS ROAD - FLINT					
		BOTTOM FEEDER	WHOLE FISH	1	28	0.02
		BOTTOM FEEDER	FILET	1	5.1	0.23
		PREDATOR	WHOLE FISH	1	1.6	0.23
		PREDATOR	FILET	0	ND	0.12
MI	KALAMAZOO RIVER - LAKE ALLEGAN					
		BOTTOM FEEDER	WHOLE FISH	1	3	0.7

TABLE D-9 RESULTS OF ANALYSES OF TIER 7 FISH - REGIONALLY SELECTED SITES

REGION	LOCATION DESCRIPTION:	TYPE OF FISH	CUT OF SAMPLE	# DETECTED	VALUE (PPT)[A]	DET LIMIT (PPT)[B]
MI	MUSKEGON LAKE - MUSKEGON	BOTTOM FEEDER	WHOLE FISH	0	ND	1.4
		BOTTOM FEEDER	F(skinless)	1	5.2	2
		PREDATOR	WHOLE FISH	1	3.9	1.6
		PREDATOR	F(skinless)	0	ND	2.4
MI	PINE RIVER - ALMA	BOTTOM FEEDER	WHOLE FISH	1	8.6	0.4
MI	ST. CLAIR RIVER - ALGONAC	BOTTOM FEEDER	WHOLE FISH	1	4.9	0.3
MN	RAINY RIVER - INTERNATIONAL FALLS	BOTTOM FEEDER	WHOLE FISH	1	23	0.52
		BOTTOM FEEDER	FILET	1	5.9	0.1
		PREDATOR	WHOLE FISH	1	85	0.11
OH	GREAT MIAMI RIVER - FRANKLIN	BOTTOM FEEDER	WHOLE FISH	1	4.8	1
		PREDATOR	WHOLE FISH	1	1.8	0.13
OH	GREAT MIAMI RIVER - HAMILTON	BOTTOM FEEDER	WHOLE FISH	2	3.7	0.3
		BOTTOM FEEDER	FILET	0	ND	0.6
OH	OHIO RIVER - EAST LIVERPOOL	BOTTOM FEEDER	WHOLE FISH	1	0.9	0.16
		PREDATOR	WHOLE FISH	1	1.08	0.03
OH	OHIO RIVER - GALLIPOLIS	PREDATOR	WHOLE FISH	1	4	0.6
OH	OHIO RIVER - MARIETTA	BOTTOM FEEDER	WHOLE FISH	1	3.6	0.03
		PREDATOR	WHOLE FISH	1	0.97	0.23
OH	OHIO RIVER - PORTSMOUTH	BOTTOM FEEDER	WHOLE FISH	1	2	0.36
		PREDATOR	WHOLE FISH	1	3.1	0.3
OH	SCIOTO RIVER - CIRCLEVILLE	BOTTOM FEEDER	WHOLE FISH	1	3.2	0.19
		PREDATOR	WHOLE FISH	1	2.7	0.4

TABLE D-9 RESULTS OF ANALYSES OF TIER 7 FISH - REGIONALLY SELECTED SITES

REGION	LOCATION DESCRIPTION:	TYPE OF FISH	CUT OF SAMPLE	# DETECTED	VALUE (PPT) [A]	DET LIMIT (PPT) [B]
	WI BLACK RIVER - BLACK RIVER FALLS	BOTTOM FEEDER	WHOLE FISH	1	4.7	0.2
		BOTTOM FEEDER	FILET	0	ND	1.4
		PREDATOR	WHOLE FISH	0	ND	0.9
		PREDATOR	FILET	0	ND	0.9
	WI ST. CROIX RIVER - ST. CROIX FALLS	BOTTOM FEEDER	WHOLE FISH	1	1.8	0.7
		BOTTOM FEEDER	FILET	0	ND	1.1
		PREDATOR	WHOLE FISH	0	ND	0.3
		PREDATOR	FILET	0	ND	0.5
6	LA BAYOU LAFOURCHE - MATHEWS	BOTTOM FEEDER	WHOLE FISH	1	1.9	0.2
		BOTTOM FEEDER	FILET	0	ND	0.72
		PREDATOR	WHOLE FISH	1	1.9	0.1
		PREDATOR	FILET	0	ND	0.67
	LA MISSISSIPPI RIVER - ST. FRANCISVILLE	BOTTOM FEEDER	WHOLE FISH	1	5.3	0.9
		BOTTOM FEEDER	FILET	0	ND	1
		PREDATOR	WHOLE FISH	1	0.7	0.2
		PREDATOR	FILET	1	0.8	0.2
	TX LAKE HOUSTON	BOTTOM FEEDER	WHOLE FISH	1	2.8	0.1
		BOTTOM FEEDER	FILET	0	ND	0.4
		PREDATOR	WHOLE FISH	0	ND	1.7
		PREDATOR	FILET	0	ND	1.2
7	IA BIG SIOUX RIVER - AKRON	BOTTOM FEEDER	WHOLE FISH	1	1.3	0.1
		BOTTOM FEEDER	FILET	0	ND	0.4
	KS ARKANSAS RIVER - DERBY	BOTTOM FEEDER	WHOLE FISH	1	0.8	0.5
		BOTTOM FEEDER	FILET	0	ND	0.2
	KS NEOSHO RIVER - CHETOPA	BOTTOM FEEDER	WHOLE FISH	1	2.4	1.2
		BOTTOM FEEDER	FILET	0	ND	0.5
		PREDATOR	WHOLE FISH	0	ND	0.7
		PREDATOR	FILET	0	ND	0.7

TABLE D-9 RESULTS OF ANALYSES OF TIER 7 FISH - REGIONALLY SELECTED SITES

REGION	LOCATION DESCRIPTION:	TYPE OF FISH	CUT OF SAMPLE	# DETECTED	A VALUE (PPT)	B DET LIMIT (PPT)
	KS TUTTLE CREEK RESERVOIR	BOTTOM FEEDER	WHOLE FISH	1	4.7	0.3
		BOTTOM FEEDER	FILET	0	ND	1.1
		PREDATOR	WHOLE FISH	0	ND	0.7
		PREDATOR	FILET	0	ND	0.8
	MO LITTLE RIVER DITCHES - HORNERSVILLE	BOTTOM FEEDER	WHOLE FISH	1	1.9	0.5
		BOTTOM FEEDER	FILET	1	0.4	0.2
		PREDATOR	WHOLE FISH	1	1.3	0.2
		PREDATOR	FILET	0	ND	0.6
	MO MISSOURI RIVER - LEXINGTON	BOTTOM FEEDER	WHOLE FISH	1	1.8	0.2
		BOTTOM FEEDER	FILET	0	ND	0.6
		PREDATOR	WHOLE FISH	0	ND	0.6
		PREDATOR	FILET	0	ND	0.1
	MO ST. FRANCIS RIVER - CARDWELL	BOTTOM FEEDER	WHOLE FISH	1	3.4	0.21
8	ND RED RIVER - PEMBINA	BOTTOM FEEDER	WHOLE FISH	1	1.8	0.72
		BOTTOM FEEDER	FILET	0	ND	0.8
		PREDATOR	WHOLE FISH	0	ND	0.72
NOT CONTAMINATED SITES:						
1	CT CONNECTICUT RIVER - MIDDLETOWN	BOTTOM FEEDER	WHOLE FISH	0	ND	0.7
	CT FARMINGTON RIVER - TARIFFVILLE	BOTTOM FEEDER	WHOLE FISH	0	ND	0.9
	CT QUINNEBAUG RIVER - JEWITT CITY	BOTTOM FEEDER	WHOLE FISH	0	ND	2
	ME SACO RIVER - UNION FALLS	BOTTOM FEEDER	WHOLE FISH	0	ND	0.3
	ME SEBAGO LAKE	PREDATOR	WHOLE FISH	0	ND	0.6

TABLE D-9 RESULTS OF ANALYSES OF TIER 7 FISH - REGIONALLY SELECTED SITES

REGION	LOCATION DESCRIPTION:	TYPE OF FISH	CUT OF SAMPLE	# DETECTED	[A] VALUE (PPT)	[B] DET LIMIT (PPT)
	NH CONNECTICUT RIVER - NORTH WALPOLE	BOTTOM FEEDER	WHOLE FISH	0	ND	1.4
	NH MERRIMACK RIVER - CONCORD	BOTTOM FEEDER	WHOLE FISH	0	ND	2
		PREDATOR	WHOLE FISH	0	ND	1.9
	NH PEMIGWASSET RIVER - PLYMOUTH	BOTTOM FEEDER	WHOLE FISH	0	ND	1
	RI BLACKSTONE RIVER - PAWTUCKET	BOTTOM FEEDER	WHOLE FISH	0	ND	0.6
	RI WOOD RIVER - ALTON	BOTTOM FEEDER	WHOLE FISH	0	ND	0.9
	VT BLACK RIVER - NEWPORT	BOTTOM FEEDER	WHOLE FISH	0	ND	0.5
		PREDATOR	WHOLE FISH	0	ND	0.3
		PREDATOR	FILET	0	ND	0.5
	VT CONNECTICUT RIVER - GUILDHALL	BOTTOM FEEDER	WHOLE FISH	0	ND	1.3
	VT LAMOILLE RIVER - EAST GEORGIA	BOTTOM FEEDER	WHOLE FISH	0	ND	0.5
	VT OTTER CREEK - WEYBRIDGE	BOTTOM FEEDER	WHOLE FISH	0	ND	1.3
		BOTTOM FEEDER	FILET	0	ND	0.9
		PREDATOR	WHOLE FISH	0	ND	1.3
		PREDATOR	FILET	0	ND	0.8
2	NJ MULLICA RIVER - GREEN BANK	BOTTOM FEEDER	WHOLE FISH	0	ND	1.5
	NJ PEQUEST RIVER - BUTZVILLE	BOTTOM FEEDER	WHOLE FISH	0	ND	1.3
	NJ TOMS RIVER - TOMS RIVER	BOTTOM FEEDER	WHOLE FISH	0	ND	2.1
	NJ WADING RIVER - JENKINS	BOTTOM FEEDER	WHOLE FISH	0	ND	0.5

TABLE D-9 RESULTS OF ANALYSES OF TIER 7 FISH - REGIONALLY SELECTED SITES

REGION	LOCATION DESCRIPTION:	TYPE OF FISH	CUT OF SAMPLE	# DETECTED[A]	VALUE (PPT)[B]	DET LIMIT (PPT)
	NY GENESSEE RIVER - BELMONT	BOTTOM FEEDER	WHOLE FISH	0	ND	0.5
	NY MOHAWK RIVER - LITTLE FALLS	BOTTOM FEEDER	WHOLE FISH	0	ND	0.5
	NY UNADILLA RIVER - ROCKDALE	BOTTOM FEEDER	WHOLE FISH	0	ND	1.7
3	DE C & D CANAL - ST. GEORGES	PREDATOR	WHOLE FISH	0	ND	1.1
	DE NANTICOKE RIVER - WOODLAND	PREDATOR	WHOLE FISH	0	ND	0.76
	MD PATAPSCO RIVER - ELICOTT CITY	BOTTOM FEEDER	WHOLE FISH	0	ND	0.6
	PA ALLEGHENY RIVER - FRANKLIN	BOTTOM FEEDER	WHOLE FISH	0	ND	2.7
	PA MONONGAHELA RIVER - CLAIRTON	BOTTOM FEEDER	WHOLE FISH	0	ND	0.69
	PA SUSQUEHANNA RIVER - COLUMBIA	BOTTOM FEEDER	WHOLE FISH	0	ND	0.7
	PA WEST BRANCH SUSQUEHANNA RIVER - LEWISBURG	BOTTOM FEEDER	WHOLE FISH	0	ND	0.8
	PA YOUNG WOMANS CREEK - RENOVO	BOTTOM FEEDER	WHOLE FISH	0	ND	0.9
	VA HOLIDAY CREEK - ANDERSONVILLE	BOTTOM FEEDER	WHOLE FISH	0	ND	0.6
	VA JAMES RIVER - CARTERSVILLE	BOTTOM FEEDER	WHOLE FISH	0	ND	0.8
	VA NOTTOWAY RIVER - SEBRELL	PREDATOR	WHOLE FISH	0	ND	1.5

TABLE D-9 RESULTS OF ANALYSES OF TIER 7 FISH - REGIONALLY SELECTED SITES

REGION	LOCATION DESCRIPTION:	TYPE OF FISH	CUT OF SAMPLE	# DETECTED	[A] VALUE (PPT)	[B] DET LIMIT (PPT)
	WV GUYANDOTTE RIVER - SALT ROCK	BOTTOM FEEDER	WHOLE FISH	0	ND	0.6
		BOTTOM FEEDER	FILET	0	ND	0.3
		PREDATOR	WHOLE FISH	0	ND	0.5
		PREDATOR	FILET	0	ND	0.3
	WV KANAWHA RIVER - GAULEY BRIDGE	PREDATOR	WHOLE FISH	0	ND	0.45
	WV LITTLE KANAWHA RIVER - PALESTINE	BOTTOM FEEDER	WHOLE FISH	0	ND	0.4
	WV SHENANDOAH RIVER- MYERSTOWN	BOTTOM FEEDER	WHOLE FISH	0	ND	0.6
	WV TYGART LAKE - GRAFTON	BOTTOM FEEDER	WHOLE FISH	0	ND	1
4	AL CHATTAHOOCHEE RIVER - EUFAULA	BOTTOM FEEDER	WHOLE FISH	0	ND	1.6
	AL CHOCTAWHATCHEE RIVER - GENEVA	BOTTOM FEEDER	WHOLE FISH	0	ND	0.7
	AL CONECUH RIVER - EAST BREWTON	BOTTOM FEEDER	WHOLE FISH	0	ND	0.7
	AL TOMBIGBEE RIVER - GAINESVILLE	BOTTOM FEEDER	WHOLE FISH	0	ND	0.6
	FL AUCILLA RIVER - SCANLON	BOTTOM FEEDER	WHOLE FISH	0	ND	1.8
	FL LAKE PARKER - LAKELAND	BOTTOM FE[illegible]R	WHOLE FISH	0	ND	1
	FL LAKE TALQUIN - TALLAHASSEE	BOTTOM FEEDER	WHOLE FISH	0	ND	0.5
	FL ST. JOHNS RIVER - PALATKA	PREDATOR	WHOLE FISH	0	ND	1.1

TABLE D-9 RESULTS OF ANALYSES OF TIER 7 FISH - REGIONALLY SELECTED SITES

REGION	LOCATION DESCRIPTION:	TYPE OF FISH	CUT OF SAMPLE	# DETECTED	[A] VALUE (PPT)	[B] DET LIMIT (PPT)
FL	ST. JOHNS RIVER @ LAKE MONROE - SANFORD	PREDATOR	WHOLE FISH	0	ND	1.5
FL	SUWANNEE RIVER - BRANFORD	BOTTOM FEEDER	WHOLE FISH	0	ND	2.4
GA	HARTWELL RESERVOIR	BOTTOM FEEDER	WHOLE FISH	0	ND	1.4
GA	LAKE SIDNEY LANIER	PREDATOR	WHOLE FISH	0	ND	0.31
GA	OGEECHEE RIVER - EDEN	BOTTOM FEEDER	WHOLE FISH	0	ND	1.3
KY	GREEN RIVER - BEECH GROVE	BOTTOM FEEDER	WHOLE FISH	0	ND	2
KY	TENNESSEE RIVER - KENTUCKY LAKE	BOTTOM FEEDER	WHOLE FISH	0	ND	0.4
KY	LICKING RIVER - CAVE RUN LAKE	BOTTOM FEEDER	WHOLE FISH	0	ND	0.5
MS	TALLAHATCHIE RIVER - SARDIS LAKE	BOTTOM FEEDER	WHOLE FISH	0	ND	3.8
NC	FRENCH BROAD RIVER - MARSHALL	BOTTOM FEEDER	WHOLE FISH	0	ND	1.4
NC	NEUSE RIVER - KINSTON	BOTTOM FEEDER	WHOLE FISH	0	ND	4.1
NC	PEE DEE RIVER - HYDRO	PREDATOR	WHOLE FISH	0	ND	1
SC	EDISTO RIVER - GIVHANS	BOTTOM FEEDER	WHOLE FISH	0	ND	1.6

TABLE D-9 RESULTS OF ANALYSES OF TIER 7 FISH - REGIONALLY SELECTED SITES

REGION	LOCATION DESCRIPTION:	TYPE OF FISH	CUT OF SAMPLE	# DETECTED	VALUE (PPT)[A]	DET LIMIT (PPT)[B]
	SC LAKE MARION - SANTEE	BOTTOM FEEDER	WHOLE FISH	0	ND	1.1
	SC LAKE WYLIE - CLOVER	BOTTOM FEEDER	WHOLE FISH	0	ND	1.8
	SC LYNCHES RIVER - EFFINGHAM	PREDATOR	WHOLE FISH	0	ND	2.1
	TN HATCHIE RIVER - BOLIVAR	PREDATOR	WHOLE FISH	0	ND	1.6
	TN HOLSTON RIVER - KNOXVILLE	BOTTOM FEEDER	WHOLE FISH	0	ND	0.3
	TN LITTLE TENNESSEE RIVER - TALLASSEE	BOTTOM FEEDER	WHOLE FISH	0	ND	2
5	IL BIG MUDDY RIVER - GRAND TOWER	BOTTOM FEEDER	WHOLE FISH	0	ND	0.7
	IL ROCK RIVER - JOSLIN	BOTTOM FEEDER	WHOLE FISH	0	ND	1.4
	IN WABASH RIVER AT DARWINS FERRY - DARWIN	BOTTOM FEEDER	WHOLE FISH	0	ND	1.7
	IN WHITE RIVER - PETERSBURG	BOTTOM FEEDER	WHOLE FISH	0	ND	1.4
	MI AUSABLE RIVER - MIO	BOTTOM FEEDER	WHOLE FISH	0	ND	0.8
	MI HURON RIVER - FLAT ROCK	BOTTOM FEEDER	WHOLE FISH	0	ND	0.2
	MI MUSKEGON RIVER AT ROGERS POND(DAM)	BOTTOM FEEDER	WHOLE FISH	0	ND	0.8
	MI RAISON RIVER - MONROE	BOTTOM FEEDER	WHOLE FISH	0	ND	0.2

TABLE D-9 RESULTS OF ANALYSES OF TIER 7 FISH - REGIONALLY SELECTED SITES

REGION	LOCATION DESCRIPTION:	TYPE OF FISH	CUT OF SAMPLE	# DETECTED	VALUE[A] (PPT)	DET LIMIT[B] (PPT)
	MI SHIAWASSEE RIVER - CHESANING	BOTTOM FEEDER	WHOLE FISH	0	ND	1.2
	MN CANNON LAKE - FARIBAULT	BOTTOM FEEDER	WHOLE FISH	0	ND	0.33
	MN MINNESOTA RIVER - MANKATO	BOTTOM FEEDER	WHOLE FISH	0	ND	0.66
	MN MISSISSIPPI RIVER - LACROSSE	BOTTOM FEEDER	WHOLE FISH	0	ND	0.48
	OH MIDDLE FORK LITTLE BEAVER CREEK - DAMASCUS	PREDATOR	WHOLE FISH	0	ND	2.5
	OH MUSKINGUM RIVER - ZANESVILLE	BOTTOM FEEDER	WHOLE FISH	0	ND	1.9
	WI FOX RIVER - WAUKESHA	BOTTOM FEEDER	WHOLE FISH	0	ND	1
	WI WISCONSIN RIVER - BIRON FLOWAGE @ BIRON	BOTTOM FEEDER	WHOLE FISH	0	ND	1
	WI WISCONSIN RIVER @ BOOM BAY - RHINELANDER	BOTTOM FEEDER	WHOLE FISH	0	ND	0.3
6	AR L'ANGUILLE - MARIANNA	BOTTOM FEEDER	WHOLE FISH	0	ND	2.5
	AR ST. FRANCIS RIVER - MADISON	BOTTOM FEEDER	WHOLE FISH	0	ND	0.48
	AR WHITE RIVER - CLARENDON	BOTTOM FEEDER	WHOLE FISH	0	ND	0.8
		BOTTOM FEEDER	FILET	0	ND	0.9
		PREDATOR	WHOLE FISH	0	ND	1.3
		PREDATOR	FILET	0	ND	1.3

TABLE D-9 RESULTS OF ANALYSES OF TIER 7 FISH - REGIONALLY SELECTED SITES

REGION	LOCATION DESCRIPTION:	TYPE OF FISH	CUT OF SAMPLE	# DETECTED	[A] VALUE (PPT)	[B] DET LIMIT (PPT)
LA	OUACHITA RIVER - JONESVILLE	BOTTOM FEEDER	WHOLE FISH	0	ND	0.6
LA	RED RIVER - ALEXANDRIA	BOTTOM FEEDER	WHOLE FISH	0	ND	1.8
LA	TOLEDO BEND RESERVOIR - ANACOCO	PREDATOR	WHOLE FISH	0	ND	0.8
NM	ELEPHANT BUTTE RESERVOIR	BOTTOM FEEDER	WHOLE FISH	0	ND	0.4
NM	GILA RIVER - REDROCK	BOTTOM FEEDER	WHOLE FISH	0	ND	0.3
NM	PECOS RIVER - RED BLUFF	BOTTOM FEEDER	WHOLE FISH	0	ND	0.8
NM	SAN JUAN RIVER - SHIPROCK	BOTTOM FEEDER	WHOLE FISH	0	ND	0.5
OK	ARKANSAS RIVER - VAN BUREN	BOTTOM FEEDER	WHOLE FISH	0	ND	1.6
OK	CIMMARON RIVER - PERKINS	BOTTOM FEEDER	WHOLE FISH	0	ND	1.3
OK	SOUTH CANADIAN RIVER - EUFAULA	BOTTOM FEEDER	WHOLE FISH	0	ND	1.9
TX	BRAZOS RIVER - SOUTH BEND	BOTTOM FEEDER	WHOLE FISH	0	ND	0.4
TX	CONCHO RIVER - PAINT ROCK	BOTTOM FEEDER	WHOLE FISH	0	ND	0.5

TABLE D-9 RESULTS OF ANALYSES OF TIER 7 FISH - REGIONALLY SELECTED SITES

REGION	LOCATION DESCRIPTION:	TYPE OF FISH	CUT OF SAMPLE	# DETECTED	VALUE (PPT)[A]	DET LIMIT (PPT)[B]
7	IA SOUTH SKUNK RIVER - AMES	BOTTOM FEEDER	WHOLE FISH	0	ND	0.2
	KS SMOKY HILL RIVER - ENTERPRISE	BOTTOM FEEDER	WHOLE FISH	0	ND	0.45
	MO GRAND RIVER - BOSWORTH	BOTTOM FEEDER	WHOLE FISH	0	ND	0.4
	MO MERAMEC RIVER - ST. JAMES	BOTTOM FEEDER	WHOLE FISH	0	ND	1.4
	MO MISSOURI RIVER - HERMANN	BOTTOM FEEDER	WHOLE FISH	0	ND	1.2
	NE LITTLE BLUE RIVER - DEWEESE	BOTTOM FEEDER	WHOLE FISH	0	ND	2.1
	NE NORTH PLATTE RIVER - McGREW	BOTTOM FEEDER	WHOLE FISH	0	ND	0.7
	NE PLATTE RIVER - GRAND ISLAND	BOTTOM FEEDER	WHOLE FISH	0	ND	1.1
8	CO ARKANSAS RIVER - BARTON	BOTTOM FEEDER	WHOLE FISH	0	ND	0.5
	CO GUNNISON RIVER - GRAND JUNCTION	BOTTOM FEEDER	WHOLE FISH	0	ND	0.4
	CO RIO GRANDE RIVER - LOBATOS	BOTTOM FEEDER	WHOLE FISH	0	ND	1.7
	CO SOUTH PLATTE RIVER - JULESBURG	BOTTOM FEEDER	WHOLE FISH	0	ND	0.7
	CO SOUTH PLATTE RIVER - LITTLETON	BOTTOM FEEDER	WHOLE FISH	0	ND	1.2
	ND HEART RIVER - MANDAN	PREDATOR	WHOLE FISH	0	ND	1.9

TABLE D-9 RESULTS OF ANALYSES OF TIER 7 FISH - REGIONALLY SELECTED SITES

REGION	LOCATION DESCRIPTION:	TYPE OF FISH	CUT OF SAMPLE	# DETECTED	VALUE (PPT)[A]	DET LIMIT (PPT)[B]
	ND KNIFE RIVER - HAZEN	BOTTOM FEEDER	WHOLE FISH	0	ND	0.3
	ND SHEYENNE RIVER - KINDRED	BOTTOM FEEDER	WHOLE FISH	0	ND	0.6
	ND SOURIS RIVER - UPHAM	BOTTOM FEEDER	WHOLE FISH	0	ND	0.3
	SD JAMES RIVER - SCOTLAND	BOTTOM FEEDER	WHOLE FISH	0	ND	0.5
	WY GREEN RIVER - GREEN RIVER	BOTTOM FEEDER	WHOLE FISH	0	ND	0.6
	WY LARAMIE RIVER - HOWELL	BOTTOM FEEDER	WHOLE FISH	0	ND	0.5
		PREDATOR	WHOLE FISH	0	ND	2.1
	WY NORTH PLATTE RIVER - ORIN	BOTTOM FEEDER	WHOLE FISH	0	ND	1.2
	WY SHOSHONE RIVER - KANE	BOTTOM FEEDER	WHOLE FISH	0	ND	0.9
	WY SNAKE RIVER - ALPINE	BOTTOM FEEDER	WHOLE FISH	0	ND	0.2
9	AZ COLORADO RIVER ABOVE IMPERIAL DAM	BOTTOM FEEDER	FILET	0	ND	1
	AZ GILA RIVER - EDEN	BOTTOM FEEDER	WHOLE FISH	0	ND	0.11
	AZ GILA RIVER - YUMA	BOTTOM FEEDER	WHOLE FISH	0	ND	0.9
	AZ ROOSEVELT LAKE	BOTTOM FEEDER	WHOLE FISH	0	ND	1.1

TABLE D-9 RESULTS OF ANALYSES OF TIER 7 FISH - REGIONALLY SELECTED SITES

REGION	LOCATION DESCRIPTION:	TYPE OF FISH	CUT OF SAMPLE	# DETECTED	VALUE (PPT)[A]	DET LIMIT (PPT)[B]
	AZ VERDE RIVER BELOW BARTLETT DAM	BOTTOM FEEDER	WHOLE FISH	0	ND	0.36
	CA MERCED RIVER-HAPPY ISLES BRIDGE-YOSEMITE NATIONAL PARK	BOTTOM FEEDER	WHOLE FISH	0	ND	0.7
	CA SACRAMENTO RIVER - HOOD	PREDATOR	WHOLE FISH	0	ND	2.8
	CA SMITH RIVER - CRESCENT CITY	BOTTOM FEEDER	WHOLE FISH	0	ND	1.9
	CA TRUCKEE RIVER - TAHOE CITY	PREDATOR	WHOLE FISH	0	ND	1.9
10	AK KENAI RIVER - SOLDOTNA	PREDATOR	WHOLE FISH	0	ND	0.9
	AK SALCHA RIVER - SALCHAKET	BOTTOM FEEDER	WHOLE FISH	0	ND	1.3
	ID CLEARWATER RIVER - SPAULDING	BOTTOM FEEDER	WHOLE FISH	0	ND	0.9
	ID SALMON RIVER - WHITEBIRD	BOTTOM FEEDER	WHOLE FISH	0	ND	1.5
	ID SNAKE RIVER - AMERICAN FALLS RESERVOIR	BOTTOM FEEDER	WHOLE FISH	0	ND	0.3
	ID SNAKE RIVER - BURLEY	BOTTOM FEEDER	WHOLE FISH	0	ND	0.6
	ID SNAKE RIVER - HEISE	BOTTOM FEEDER	WHOLE FISH	0	ND	0.6
	OR DESCHUTES RIVER AT MOODY - BIGGS	BOTTOM FEEDER	WHOLE FISH	0	ND	1.6
	OR JOHN DAY RIVER AT MCDONALD FERRY - RUFUS	BOTTOM FEEDER	WHOLE FISH	0	ND	0.8

TABLE D-9 RESULTS OF ANALYSES OF TIER 7 FISH - REGIONALLY SELECTED SITES

REGION	LOCATION DESCRIPTION:	TYPE OF FISH	CUT OF SAMPLE	# DETECTED	[A] VALUE (PPT)	[B] DET LIMIT (PPT)
OR	MCKENZIE RIVER - COBURG	BOTTOM FEEDER	WHOLE FISH	0	ND	0.6
OR	MINAM RIVER NEAR MINAM	BOTTOM FEEDER	WHOLE FISH	0	ND	1.6
OR	ROGUE RIVER BELOW GRANTS PASS	BOTTOM FEEDER	WHOLE FISH	0	ND	0.4
OR	SANTIAM RIVER - JEFFERSON	BOTTOM FEEDER BOTTOM FEEDER	WHOLE FISH FILET	0 0	ND ND	1.5 1.4
OR	UMPQUA RIVER - ELKTON	PREDATOR	WHOLE FISH	0	ND	0.9
OR	WILLAMETTE RIVER - SALEM	BOTTOM FEEDER	WHOLE FISH	0	ND	2.1
WA	CHEHALIS RIVER - PORTER	BOTTOM FEEDER	WHOLE FISH	0	ND	0.4
WA	MOSES LAKE - ALTMET	BOTTOM FEEDER	WHOLE FISH	0	ND	1.6
WA	NISQUALLY RIVER - McKENNA	BOTTOM FEEDER	WHOLE FISH	0	ND	0.4
WA	PEND OREILLE RIVER - DALKENA	BOTTOM FEEDER	WHOLE FISH	0	ND	1.6
WA	SKAGIT RIVER - MT. VERNON	BOTTOM FEEDER	WHOLE FISH	0	ND	0.6
WA	SNAKE RIVER - TUCANNON	BOTTOM FEEDER	WHOLE FISH	0	ND	1
WA	SPOKANE RIVER - LONG LAKE	BOTTOM FEEDER	WHOLE FISH	0	ND	1.8

TABLE D-10 RESULTS OF ANALYSES OF TIER 7 FISH - GREAT LAKES AREA

REGION	LOCATION DESCRIPTION:	TYPE OF FISH	CUT OF SAMPLE	# DETECTED	VALUE (PPT)[A]	DET LIMIT (PPT)[B]
CONTAMINATED SITES[C]:						
2	NY LAKE ONTARIO - BUFFALO RIVER	BOTTOM FEEDER	WHOLE FISH	1	1.9	0.6
		BOTTOM FEEDER	FILET	1	0.76	0.4
	NY LAKE ONTARIO - EIGHTEEN MILE CREEK	BOTTOM FEEDER	WHOLE FISH	1	6.3	0.5
		BOTTOM FEEDER	FILET	0	ND	0.65
		PREDATOR	WHOLE FISH	1	20	0.2
		PREDATOR	FILET	1	3.6	0.5
	NY LAKE ONTARIO - NIAGARA RIVER	BOTTOM FEEDER	WHOLE FISH	1	11	0.4
		BOTTOM FEEDER	FILET	1	8.4	0.1
		PREDATOR	WHOLE FISH	1	5.8	0.1
		PREDATOR	FILET	1	2.3	0.1
	NY LAKE ONTARIO - OLCOTT	PREDATOR	WHOLE FISH	1	18	1.4
		PREDATOR	FILET	1	13	0.7
	NY LAKE ONTARIO - ROCHESTER	PREDATOR	WHOLE FISH	1	13	0.6
		PREDATOR	FILET	1	12	0.3
	NY LAKE ONTARIO - WILSON	PREDATOR	WHOLE FISH	1	23	0.3
		PREDATOR	FILET	1	9	0.9
5	MI LAKE ERIE - TRENTON CHANEL	BOTTOM FEEDER	WHOLE FISH	1	14	0.8
		BOTTOM FEEDER	FILET	1	2.7	0.1
		PREDATOR	WHOLE FISH	0	ND	1.6
		PREDATOR	FILET	0	ND	0.4
	MI LAKE ERIE - RIVER ROUGE	BOTTOM FEEDER	WHOLE FISH	1	24.1	1.8
		BOTTOM FEEDER	FILET	1	4.4	0.26
		PREDATOR	WHOLE FISH	1	3.4	1.01
		PREDATOR	FILET	0	ND	0.68

A IF MORE THAN ONE VALUE REPORTED FOR ONE TYPE OF SAMPLE, THE HIGHEST VALUE IS SHOWN

B BIOLOGICAL TISSUE LEVELS BASED ON WET WEIGHT

C CONTAMINATION DEFINED AS DETECTABLE LEVELS

TABLE D-10 RESULTS OF ANALYSES OF TIER 7 FISH - GREAT LAKES AREA

REGION LOCATION DESCRIPTION:	TYPE OF FISH	CUT OF SAMPLE	# DETECTED	VALUE (PPT)[A]	DET LIMIT (PPT)[B]
MI LAKE ERIE - DETROIT RIVER (BELLE ISLE)	BOTTOM FEEDER	WHOLE FISH	1	9.1	0.1
	BOTTOM FEEDER	FILET	1	8	0.1
	PREDATOR	WHOLE FISH	2	3.8	0.1
	PREDATOR	FILET	0	ND	0.58
MI LAKE HURON - ROCKPORT	PREDATOR	WHOLE FISH	1	5.0	1.[illegible]
	PREDATOR	FILET	1	9.8	0.2
MI LAKE MICHIGAN - SAUGATUCK	PREDATOR	WHOLE FISH	1	4	1.4
	PREDATOR	FILET	1	6.5	0.25
MI LAKE MICHIGAN - WHITE LAKE	BOTTOM FEEDER	WHOLE FISH	2	1.8	0.45
	BOTTOM FEEDER	FILET	0	ND	0.21
	PREDATOR	WHOLE FISH	1	1.1	0.1
	PREDATOR	FILET	0	ND	0.43
MI LAKE ST.CLAIR - ANCHOR BAY	PREDATOR	WHOLE FISH	1	5.8	0.95
	PREDATOR	FILET	1	2.3	0.3
MI LAKE HURON - SAGINAW BAY - CASEVILLE	BOTTOM FEEDER	WHOLE FISH	1	18	0.5
	BOTTOM FEEDER	FILET	1	13.2	0.4
	PREDATOR	WHOLE FISH	1	6.8	0.1
	PREDATOR	FILET	1	0.7	0.2
NY LAKE ONTARIO - OSWEGO	PREDATOR	FILET	2	41	1.1
OH LAKE ERIE - BLACK RIVER	BOTTOM FEEDER	WHOLE FISH	1	2.4	1
OH LAKE ERIE - CUYAHOGA RIVER	BOTTOM FEEDER	WHOLE FISH	1	3.1	0.19
WI LAKE MICHIGAN - FOX RIVER	BOTTOM FEEDER	WHOLE FISH	1	5.3	0.3
	BOTTOM FEEDER	FILET	1	1.2	0.3
	PREDATOR	WHOLE FISH	1	6	1.5
	PREDATOR	FILET	0	ND	0.48

TABLE D-10 RESULTS OF ANALYSES OF TIER 7 FISH - GREAT LAKES AREA

REGION	LOCATION DESCRIPTION:	TYPE OF FISH	CUT OF SAMPLE	# DETECTED	VALUE (PPT)[A]	DET LIMIT (PPT)[B]
	WI LAKE MICHIGAN - MENOMINEE RIVER	BOTTOM FEEDER	WHOLE FISH	1	7.3	0.7
		BOTTOM FEEDER	FILET	1	8	0.1
		PREDATOR	WHOLE FISH	1	1.4	0.1
		PREDATOR	FILET	1	1.8	0.2
	WI LAKE MICHIGAN - OCONTO RIVER	BOTTOM FEEDER	WHOLE FISH	1	3.6	0.5
		BOTTOM FEEDER	FILET	1	1.2	0.2
		PREDATOR	WHOLE FISH	0	ND	1.5
		PREDATOR	FILET	0	ND	0.2
	WI LAKE MICHIGAN - PESTICO RIVER	BOTTOM FEEDER	WHOLE FISH	1	8.5	0.6
		BOTTOM FEEDER	FILET	1	3.5	0.29
		PREDATOR	WHOLE FISH	1	1.5	0.38
		PREDATOR	FILET	0	ND	0.22
	WI LAKE SUPERIOR - ASHLAND	BOTTOM FEEDER	WHOLE FISH	1	4.8	0.4
		BOTTOM FEEDER	FILET	0	ND	1.3
	WI LAKE SUPERIOR - SUPERIOR	BOTTOM FEEDER	WHOLE FISH	1	15	0.2
		BOTTOM FEEDER	FILET	1	5.2	0.71
		PREDATOR	WHOLE FISH	1	5.2	0.46
		PREDATOR	FILET	0	ND	1.2
NOT CONTAMINATED SITES:						
2	NY LAKE ONTARIO - CAPE VINCENT	BOTTOM FEEDER	WHOLE FISH	0	ND	1.4
3	PA LAKE ERIE - ERIE	BOTTOM FEEDER	WHOLE FISH	0	ND	1.2
5	LAKE SUPERIOR - APOSTLE ISLAND	PREDATOR	WHOLE FISH	0	ND	3.1
	MI LAKE MICHIGAN - MANISTIQUE RIVER	BOTTOM FEEDER	WHOLE FISH	0	ND	0.9
	OH LAKE ERIE - BASS ISLAND	PREDATOR	WHOLE FISH	0	ND	1.8
	OH LAKE ERIE - MAUMEE RIVER	BOTTOM FEEDER	WHOLE FISH	0	ND	1.5

TABLE D-11 RESULTS OF ANALYSES OF TIER 7 FISH - ESTUARINE AREAS

REGION	LOCATION DESCRIPTION:	MATRIX TYPE	# SAMPLED	# DETECTED[A]	VALUE (PPT)[B]	DET LIMIT (PPT)
CONTAMINATED SITES:[C]						
1	RI NARRAGANSETT BAY - NARRAGANSETT	MUSSELS	1	1	3.5	1.7
2	NJ SANDY HOOK BAY- LEONARDO	MUSSELS	1	1	1.08	0.03
6	LA GARDEN ISLAND BAY - VENICE	BOTTOM FEEDER-FILET BOTTOM FEEDER-WHOLE	1 1	0 1	ND 3.3	1.8 0.1
	TX TRINITY BAY	OYSTERS	1	1	2.2	0.3
NOT CONTAMINATED SITES:						
1	MA MASSACHUSETTS BAY - ICABODS FLATS - KINGSTON	MUSSELS	1	0	ND	0.6
	ME PENOBSCOT BAY;SO. CRESENT BEACH - OWLS HEAD	MUSSELS	1	0	ND	0.8
2	NJ ATLANTIC CITY - ATLANTIC CITY	MUSSELS	1	0	ND	1.4
	NJ CAPE MAY- CAPE MAY	MUSSELS	1	0	ND	1
	NY MORICHES INLET - BROOKHAVEN	MUSSELS	1	0	ND	0.3
	NY ROCKAWAY POINT - QUEENS CO.	MUSSELS	1	0	ND	0.7
3	DE DELAWARE BAY - PORT MAHON	OYSTERS	1	0	ND	0.36

A IF MORE THAN ONE VALUE REPORTED FOR ONE TYPE OF SAMPLE, THE HIGHEST VALUE IS SHOWN

B BIOLOGICAL TISSUE LEVELS BASED ON WET WEIGHT

C CONTAMINATION DEFINED AS DETECTABLE LEVELS

TABLE D-11 RESULTS OF ANALYSES OF TIER 7 FISH - ESTUARINE AREAS

REGION	LOCATION DESCRIPTION:	MATRIX TYPE	# SAMPLED	# DETECTED[A]	VALUE (PPT)[B]	DET LIMIT (PPT)
	DE DELAWARE BAY @ CAPE HENELOPEN - LEWES	MUSSELS	1	0	ND	0.14
	MD ASSATEAGUE	HARD CLAMS	1	0	ND	0.6
	MD CHOPTANK RIVER - CHOPTANK	OYSTERS	1	0	ND	0.7
	MD NORTHERN CHESAPEAKE BAY - DEALE ISLAND	OYSTERS	2	0	ND	1.4
	MD NORTHERN CHESAPEALE BAY -TILGHMAN ISLAND	OYSTERS	1	0	ND	1.3
	MD POCOMOKE RIVER - POCOMOKE CITY	HOGCHOKER	1	0	ND	0.4
	VA BRICK KILN CREEK - HAMPTON	OYSTERS	1	0	ND	2.9
	VA CAPE CHARLES - CAPE CHARLES	OYSTERS	1	0	ND	0.9
	VA LYNNHAVEN BAY	OYSTERS	1	0	ND	0.9
	VA RAPPAHANOCK RIVER - TAPPAHANOCK	OYSTERS	1	0	ND	0.5
4	FL CAT POINT BARRIER - APALACHICOLA BAY	OYSTERS	1	0	ND	0.3
	FL CEDAR KEY	OYSTERS	1	0	ND	0.3
	FL ROOKERY BAY - NAPLES	OYSTERS	1	0	ND	0.95
	GA SAVANNAH RIVER - SAVANNAH	OYSTERS	1	0	ND	0.5

TABLE D-11 RESULTS OF ANALYSES OF TIER 7 FISH - ESTUARINE AREAS

REGION	LOCATION DESCRIPTION:	MATRIX TYPE	# SAMPLED	# DETECTED[A]	VALUE (PPT)[B]	DET LIMIT (PPT)
	MS BILOXI BAY - OCEAN SPRINGS	OYSTERS	1	0	ND	0.9
	MS MISSISSIPPI SOUND - PASS CHRISTIAN	OYSTERS	1	0	ND	0.9
	NC CAPE FEAR RIVER	OYSTERS	1	0	ND	0.8
	NC HATTERAS ISLAND	OYSTERS	1	0	ND	0.6
	SC CHARLESTON HARBOR - CHARLESTON	OYSTERS	1	0	ND	0.7
6	LA BARATARIA BAY	OYSTERS	1	0	ND	0.5
	LA CALCASIEU RIVER - CAMERON	OYSTERS	1	0	ND	0.82
	LA LAKE BORGNE - CHALMETTE	OYSTERS	1	0	ND	0.3
	LA LAKE PONTCHARTRAIN	SHELLFISH	1	0	ND	2.3
	LA TIMBALIER BAY - LEEVILLE	OYSTERS	1	0	ND	1.7
	LA VERMILLION BAY - GULF OF MEXICO	OYSTERS	1	0	ND	0.5
	TX ARANSAS BAY	FISH-BOTTOM FEEDER OYSTERS	1 1	0 0	ND ND	1 0.41
	TX GALVESTON BAY	OYSTERS	1	0	ND	3.2
	TX MATAGORDA BAY	OYSTERS	1	0	ND	1.2

TABLE D-11 RESULTS OF ANALYSES OF TIER 7 FISH - ESTUARINE AREAS

REGION	LOCATION DESCRIPTION:	MATRIX TYPE	# SAMPLED	# DETECTED[A]	VALUE (PPT)[B]	DET LIMIT (PPT)
	TX SABINE LAKE	OYSTERS	1	0	ND	0.77
	TX SAN ANTONIO BAY	FISH-BOTTOM FEEDER	1	0	ND	0.9
		OYSTERS	1	0	ND	0.94
9	CA FARALLON ISLANDS	MUSSELS	1	0	ND	1.5
	CA POINT ARGUELLO - LOMPOC	MUSSELS	1	0	ND	1.9
	CA POINT LA JOLLA - LA JOLLA	MUSSELS	1	0	ND	1.7
	CA POINT SAN PEDRO - PACIFICA	MUSSELS	1	0	ND	0.9
	CA SAN PABLO BAY - RODEO	MUSSELS	1	0	ND	1.1
	CA SAN PEDRO HARBOR - LONG BEACH	MUSSELS	1	0	ND	1.1
	CA SANTA CATALINA ISLAND - SANTA CATALINA	MUSSELS	1	0	ND	0.5
	CA SOUTH SAN FRANCISCO BAY - SAN FRANCISCO	MUSSELS	1	0	ND	2.4
10	AK CHILKAT BAY - HAINES	MUSSELS	1	0	ND	0.8
	AK KACHEMAK BAY - HOMER	MUSSELS	1	0	ND	0.9
	AK ORCA BAY - CORDOVA	MUSSELS	1	0	ND	1

TABLE D-11 RESULTS OF ANALYSES OF TIER 7 FISH - ESTUARINE AREAS

REGION	LOCATION DESCRIPTION:	MATRIX TYPE	# SAMPLED	# DETECTED[A]	VALUE (PPT)[B]	DET LIMIT (PPT)
OR	COOS BAY AT S. SLOUGH - CHARLESTOWN	OYSTERS	1	0	ND	0.8
OR	TILLAMOOK BAY - BAY CITY	OYSTERS	1	0	ND	0.4
OR	YAQUINA BAY - NEWPORT	OYSTERS	1	0	ND	0.5
WA	PUGET SOUND - MANCHESTER	MUSSELS	1	0	ND	2.7
WA	WILLAPA BAY - TOKELAND	MUSSELS	1	0	ND	1.5

APPENDIX D-10

SUMMARY OF INDUSTRIAL FACILITIES LOCATED NEAR STATISTICALLY SELECTED TIER 7 FISH SAMPLING SITES

SITE NAME	Number of Facilities Located Near Sampling Sites*																										
	Pulp & Paper Mills			Steam Electric			Organic Chem & Pesticides			Inorganic Chem & Pesticides			Superfund Sites			POTW			Metal Discharging Industry			Other Industrial Categories			Miscellaneous Industries		
	Mainstem		Tribs	Mainstem		Tribs	Mainstem		Tribs	Mainstem		Tribs	Mainstem		Tribs	Mainstem		Tribs	Mainstem		Tribs	Mainstem		Tribs	Mainstem		Tribs
	Up	Down	Up	Up	Down	Up	Up	Down	Up	Up	Down	Up	Up	Down	Up	Up	Down	Up	Up	Down	Up	Up	Down	Up	Up	Down	Up
Region I																											
CONTAMINATED																											
Androscoggin @ Brunswick, ME	2	-	-	2	-	-	-	-	1	-	-	-	-	-	-	2	-	1	1	-	1	-	-	2	1	-	-
NONCONTAMINATED																											
Connecticut @ Thompsonville, CT	8	-	5	2	-	-	-	-	1	1	-	-	-	-	-	4	1	4	4	-	5	3	-	3	1	1	2
Narraguagus @ Cherryfield, ME	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Region II																											
NONCONTAMINATED																											
Raritan @ Queens Bridge, NJ	1	-	2	-	-	-	3	1	4	-	-	5	1	-	5	3	1	22	10	2	13	5	1	10	7	1	9
Nissequogue near Smithtown, NY	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2ᵇ	-	-	-	-	-	-	-	-	-	-
Tonawanda Creek @ Batavia, NY	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	3	1	-	2	1	-	-	1	-	2	2	-
Richelieu @ Rouses Pt, NY	-	-	-	1ᵃ	-	-	-	-	-	-	-	-	-	-	-	18ᵃ	-	-	-	-	-	-	-	-	-	-	-
Region III																											
CONTAMINATED																											
Schuylkill @ Philadelphia, PA	3	-	-	2	1	-	2	-	-	2	-	1	2	-	2	15	-	13	18	2	18	8	-	2	5	1	3
Susquehanna @ Conowingo, MD	-	-	-	4	1	1	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-
NONCONTAMINATED																											
Pamunkey near Hanover, VA	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	5	1	-	-	1	-	-	-	2	-	3
Appomattox @ Matoaca, VA	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	7	5	-	-	1	-	-	-	-	-	1	-
Region IV																											
CONTAMINATED																											
Yazoo @ Redwood, MS	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-
NONCONTAMINATED																											
Alabama near Montgomery, Al	-	-	-	-	-	-	2	-	-	-	-	-	-	-	-	2	1	-	2	-	-	1	-	-	1	-	-
Escatawpa near Agricola, MS	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-
St. Marys near Macclenny, FL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-
Main Canal @ Vero Beach, FL	-	-	-	-	1ᵇ	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1ᵇ	-	-
Fisheating Creek @ Palmdale, FL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Chipola near Altha, FL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	2	-	-	-	-	-	1	-	-	-	-	-
Econfina Creek near Bennet, FL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Chattahoochee Andrew L&D nr. Columbia, GA		-	-	-	1	-	-	-	-	-	-	1	-	-	-	2	-	4	-	-	3	-	-	1	-	-	-
Big Sandy @ Louisa, KY	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	1	-	1	11	-	12	-	-	-	1	-	-
Cypress Creek near Janice, MS	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Cataloochee Creek near Cataloochee, NC	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Coosawhatchie near Hampton, SC	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2	-	1	-	-	-	-	-	-	-	-	-
Clinch @ Milton Hill Dam, TN	-	-	-	2	-	-	-	-	-	1	-	-	-	-	-	2	-	-	-	-	-	-	-	-	2	-	-
Buffalo near Flat Woods, TN	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2	-	-	1	-	-	-	-	-	1
Region V																											
CONTAMINATED																											
Wabash @ New Harmony, IN	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	1	6	-	-	-	1	-	-	-	-	1
Rainy @ Manitou Rapids, MN	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Little Miami @ Milford, OH	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	10	4	5	3	-	1	2	-	-	9	2	7
Muskegon near Bridgeton, MI	-	-	-	2	-	-	-	-	-	-	-	-	-	-	-	2	1	-	-	-	-	-	-	-	1	-	-
Great Miami @ New Baltimore, OH	2	-	-	1	-	-	-	-	-	1	1	-	1	-	-	17	-	6	7	-	1	1	-	-	6	-	1
Nemadji near South Superior, WI	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	1	-	-	-	-	-	1	-	2	-	-

APPENDIX D-10 (Continued)

SUMMARY OF INDUSTRIAL FACILITIES LOCATED NEAR STATISTICALLY SELECTED TIER 7 FISH SAMPLING SITES
(Continued)

SITE NAME	Number of Facilities Located Near Sampling Sites*																										
	Pulp & Paper Mills			Steam Electric			Organic Chem & Pesticides			Inorganic Chem & Pesticides			Superfund Sites			POTW			Metal Discharging Industry			Other Industrial Categories			Miscellaneous Industries		
	Mainstem		Tribs	Mainstem		Tribs	Mainstem		Tribs	Mainstem		Tribs	Mainstem		Tribs	Mainstem		Tribs	Mainstem		Tribs	Mainstem		Tribs	Mainstem		Tribs
	Up	Down	Up	Up	Down	Up	Up	Down	Up	Up	Down	Up	Up	Down	Up	Up	Down	Up	Up	Down	Up	Up	Down	Up	Up	Down	Up
Region V (Continued)																											
NONCONTAMINATED																											
Tahquamenon near Tahquamenon Paradise, MI		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
St. Marys above Sault St. Marie, MI	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	4[a]	-	-	1[a]	-	-	-	-	-	5[a]	-	-
Manistee @ Manistee, MI	-	-	1	1	-	-	-	-	-	1	-	-	-	-	-	-	-	1	-	-	1	2	-	1	1	1	1
Bifle near Sterling, MI	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	1	1	-	-	-	-	-	-	-	2
Washington Creek @ Windigo Isle Royale, MI		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Minnesota near Jordan, MN	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2	-	3	-	-	-	1	-	-	2	-	-
Region VI																											
CONTAMINATED																											
Mississippi near Arkansas City, AR	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Red @ Index, AR	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2	-	-	1	-	-	-	-	-	-	-	-
Washita near Durwood, OK	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	1	-	2	-	-	-	-	-	1	-	-	1
Boeuf near Fort Necessity, LA	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-
NONCONTAMINATED																											
Sulphur south of Texarkana, AR	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	4	-	-	1	-	-	-	-	-	-
North Sylamore Creek near Fifty Six, AR		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-
Tangipahoa @ Robert, LA	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2	-	-	-	-	-	-	-	-	-	-	-
Canadian above NM-TX state line, NM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Rio Mora near Terrero, NM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Kiamichi near Big Cedar, OK	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	13[a]	2	-	2[a]	-	-	-	-	-	3[a]	-	-
Red @ Denison Dam near Denison, OK	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	4	-	8	-	-	-	-	-	-	-	-	-
Trinity @ Romayor, TX	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	3	-	3	-	-	-	-	-	-	-	-	-
Brazos near Highbank, TX	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	1	-	-	-	-	-	-	-	-	-
Little @ Cameron, TX	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Colorado above Silver, TX	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	4	-	-	-	-	-	-	-	-	-	-	-
Lavaca near Edna, TX	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-
Guadalupe @ Victoria, TX	-	-	-	1	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
South Fork Rocky Creek near Briggs, TX	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Region VII																											
CONTAMINATED																											
Platte @ Louisville, NE	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	2	-	7	-	-	-	-	-	-	-	-	1
NONCONTAMINATED																											
Iowa @ Wapello, IA	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-
Nishnabotna above Hamburg, IA	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	1	-	-	-	-	-	-	1	-	1
Missouri @ Omaha, NE	-	-	-	1	1	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	1
Osage near Schell City, MO	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2	-	-	-	-	-	-	-	-	1
Region VIII																											
NONCONTAMINATED																											
Colorado near CO-UT state line, CO	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-
Missouri @ Fort Benton, MT	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-
Missouri @ Virgelle, MT	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Yellowstone @ Billings, MT	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	3	-	1	-	-	-	2	1	-	1	-	-
Powder near Locate, MT	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Flathead @ Columbia Falls, MT	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	1	-	-
Rock Creek below Horse Creek, MT	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Little Missouri near Watford City, ND	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Castle Cr. above Deerfield Res., SD	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Delores near Cisco, UT	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
North Platte @ Alcova, WY	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Cache Creek near Jackson, WY	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-

APPENDIX D-10 (Continued)

SUMMARY OF INDUSTRIAL FACILITIES LOCATED NEAR STATISTICALLY SELECTED TIER 7 FISH SAMPLING SITES
(Continued)

Number of Facilities Located Near Sampling Sites*

SITE NAME	Pulp & Paper Mills			Steam Electric			Organic Chem & Pesticides			Inorganic Chem & Pesticides			Superfund Sites			POTW			Metal Discharging Industry			Other Industrial Categories			Miscellaneous Industries		
	Mainstem		Tribs	Mainstem		Tribs	Mainstem		Tribs	Mainstem		Tribs	Mainstem		Tribs	Mainstem		Tribs	Mainstem		Tribs	Mainstem		Tribs	Mainstem		Tribs
	Up	Down	Up	Up	Down	Up	Up	Down	Up	Up	Down	Up	Up	Down	Up	Up	Down	Up	Up	Down	Up	Up	Down	Up	Up	Down	Up
Region IX																											
CONTAMINATED																											
Owens below Tinemaha Dam, CA	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
NONCONTAMINATED																											
San Luis Rey @ Oceanside, CA	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1	–
Santa Clara @ LA-Ventura line, CA	–	–	–	–	–	1	1	–	–	–	–	–	–	–	–	2	–	–	1	–	–	1	–	–	–	–	1
San Joaquin near Vernalis, CA	–	–	1	–	–	–	–	–	–	–	–	1	–	–	–	3	–	1	–	–	–	1	–	–	–	–	2
Klamath near Klamath Glen, CA	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Halawa Stream near Halawa, HI	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Honolii Stream near Papaikou, HI	–	–	–	2^a	–	–	–	–	–	–	–	–	–	–	–	9^d	–	–	–	–	–	–	–	–	1^d	–	–
Colorado below Hoover Dam, NV	–	–	–	2^a	1	–	1^a	–	–	2^a	–	–	–	–	–	2^a	–	–	1^a	–	–	–	–	–	–	–	–
Humboldt near Carlin, NV	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1	–	–	–	–	–	–	–	–	1	–	–
Region X																											
CONTAMINATED																											
Willamette @ Portland, OR	2	–	–	–	2^c	–	–	2^c	–	–	2^c	–	–	–	–	5	1^c	2	5^c	–	–	4^c	–	–	4	9^c	4
NONCONTAMINATED																											
Susitna @ Susitna Station, AK	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1^d	–	–	13^d	–	–	1^d	–	–	3^d	–	–
Snake @ King Hill, ID	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Columbia @ Warrendale, OR	–	–	–	1	–	–	–	–	–	–	–	–	–	–	–	3	–	2	1	–	–	1	–	–	3	–	2
Willapa near Willapa, WA	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1
Puyallup @ Puyallup, WA	–	–	1	–	–	–	–	–	–	–	–	–	–	–	–	1	–	7	–	–	1	–	–	–	1	–	2
Snohomish near Monroe, WA	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1	–	2	–	–	–	–	–	–	–	–	1
Okanogan @ Malott, WA	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	2	–	–	–	–	–	–	–	–	2	–	1

[a] Facilities located within a 30 mile radius of the dioxin site.
[b] Facilities located 3 miles downstream on the coastline of the Atlantic Ocean.
[c] Facilities on shoreline of wide river, they could not be specifically located except as either within 5 miles downstream or 11 miles upstream.
[d] Reach is not digitized. Summarization based on data from IFD and Water Supply Utility Database on facilities located within a 30 mile radius of the dioxin site.

*The facilities summarized are located within 3 miles downstream on the mainstem or 30 miles upstream on the mainstem and tributaries of the Tier 7 Fish Sampling site. The industrial catgories include the facilities in the following SIC codes:

- Pulp and Paper – SIC 2611, 2621, 2631, 2641, 2642, 2643, 2645, 2646, 2647, 2648, 2649, 2651, 2652, 2653, 2654, 2655, and 2661
- Steam Electric – SIC 4911 and 4931
- Organic Chemicals, Plastics, and Synthetic Fibers and Pesticides Manufacturers SIC 2821, 2823, 2824, 2865, and 2869
- Inorganic Chemicals and Pesticides Manufacturers – SIC 2812, 2813, 2816, and 2819
- Superfund Sites – SIC 6999
- POTWs – SIC 4952 and 4954
- Metal Discharging Industry – Includes all facilities identified in the following industrial categories: Aluminum Forming, Battery Manufacturing, Coal Mining, Coil Coating, Foundries, Iron & Steel, Metal Finishing, Nonferrous Metals, Ore Mining, Paint, Porcelain Enameling, Copper Forming, Ink, Auto and Other Laundries, Photographics, and Electrical Components
- Other Industrial Categories – Includes all facilities identified in the following industrial categories: Leather Tanning, Textiles, Timber, Pharmaceuticals, Petroleum Refining, Misc. Chemicals, Argicultural Chemicals, Misc. Petroleum Products.
- Miscellaneous Industries – Includes all the remaining industrial categories, such as food products, Lumber, Real Estate.

APPENDIX D-11

SUMMARY OF INDUSTRIAL FACILITIES LOCATED NEAR REGIONALLY SELECTED TIER 7 FISH SAMPLING SITES

SITE NAME	Number of Facilities Located Near Sampling Sites*																										
	Pulp & Paper Mills			Steam Electric			Organic Chem & Pesticides			Inorganic Chem & Pesticides			Superfund Sites			POTW			Metal Discharging Industry			Other Industrial Categories			Miscellaneous Industries		
	Mainstem		Tribs	Mainstem		Tribs	Mainstem		Tribs	Mainstem		Tribs	Mainstem		Tribs	Mainstem		Tribs	Mainstem		Tribs	Mainstem		Tribs	Mainstem		Tribs
	Up	Down	Up	Up	Down	Up	Up	Down	Up	Up	Down	Up	Up	Down	Up	Up	Down	Up	Up	Down	Up	Up	Down	Up	Up	Down	Up
Region 1																											
CONTAMINATED																											
Kennebec near north Sidney, ME	4	-	-	2	-	1	-	-	-	-	-	-	-	-	-	3	-	1	-	-	-	2	-	2	-	-	-
Penobscot @ Eddington, ME	2	-	-	3	-	1	-	-	-	-	-	-	-	-	-	7	1	-	-	1	-	-	-	-	-	-	-
Androscoggin @ Lewiston, ME	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2	-	-	-	-	-	-	-	-	-	-	-
Nashua @ Pepperell, MA	1	2	1	1	-	-	4	-	1	-	-	-	-	-	-	2	-	1	3	-	2	4	-	1	-	-	-
Merrimack @ Tyngs Island, MA	-	-	3	1	-	-	1	-	-	1	-	1	2	-	2	3	-	3	5	-	14	2	3	5	-	-	2
Quinnipiac @ North Haven, CT	-	-	-	-	-	-	1	-	-	1	-	-	2	-	-	3	-	-	39	-	-	-	-	-	3	-	-
Connecticut @ Newbury, VT	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	2	-	-	-	-	-	-	-	-	-
Blackstone @ Millville, MA	-	1	-	-	-	-	1	-	1	-	-	-	2	1	-	5	-	2	10	-	5	3	1	2	1	-	1
NONCONTAMINATED																											
Maine																											
Sebago Lake	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1*	-	-	-	-	-	-	-	-	-	-	-
Saco @ Union Falls	1	-	-	3	1	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-
New Hampshire																											
Merrimack @ Concord	-	-	1	1	-	-	-	-	-	-	-	-	-	-	-	4	1	3	2	-	-	1	-	-	-	1	-
Connecticut @ North Walpole	2	-	3	-	-	-	-	-	-	-	-	-	-	-	1	2	-	5	1	-	1	1	-	1	-	-	-
Pemigewasset @ Plymouth	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2	-	2	-	-	-	-	-	-	-	-	-
Vermont																											
Lamoille @ East Georgia	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-
Otter Creek @ Huntington Falls Dam	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	1	-	-	-	1	-	-	-	-	1	-	-
Black @ Newport	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Connecticut @ Guildhall	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-
Massachusetts																											
Westfield @ Westfield	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	1	1	-	-	-	-	-	-	-	2	-
Rhode Island																											
Blackstone @ Pawtucket	1	-	-	-	-	-	1	-	-	-	-	-	5	-	-	4	-	1	11	3	1	6	-	1	2	-	-
Wood @ Alton (Alton Pond)	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Connecticut																											
Farmington @ Tariffville	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	6	-	1	17	-	-	-	-	-	1	-	-
Connecticut @ Middletown	-	-	2	1	-	-	-	-	1	-	-	-	-	-	-	7	-	5	16	-	13	-	-	1	5	2	1
Quinnebaug @ Jewett City	3	-	-	-	-	-	1	-	-	-	-	-	1	-	-	4	-	-	3	-	2	3	-	-	2	-	-
Region 2																											
CONTAMINATED																											
Hudson @ Peekskill, NY	-	-	1	2	2	-	-	-	-	-	-	-	1	-	-	7	-	21	-	-	5	1	-	1	4	-	-
Hudson @ Green Island, NY	2	-	1	-	-	-	-	-	1	-	-	-	-	-	-	1	1	14	-	1	4	1	-	4	1	-	1
Passaic @ Paterson, NJ	-	-	3	-	-	1	1	-	3	-	-	1	1	-	9	3	3	40	13	10	30	2	10	8	4	3	8
NONCONTAMINATED																											
New York																											
Mohawk @ Little Falls	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	9	-	4	4	-	-	2	-	-	2	-	-
Genesee @ Belmont	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	2	-	2	4	-	-	-	-	3	1	-	4
Unadilla @ Rockdale	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2	-	1	-	-	-	-	-	-	1	-	-
New Jersey																											
Pequest @ Buttzville	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	1	1	-	-	-	1	-	-	1	-	-
Toms @ Toms River (NASQAN)	-	-	-	-	-	-	-	-	-	-	-	-	1	1	-	-	-	1	-	1	-	-	-	-	-	-	-
Wading @ Jenkins	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-
Mullica @ Green Bank	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

APPENDIX D-11 (Continued)

SUMMARY OF INDUSTRIAL FACILITIES LOCATED NEAR REGIONALLY SELECTED TIER 7 FISH SAMPLING SITES

SITE NAME	Number of Facilities Located Near Sampling Sites*																										
	Pulp & Paper Mills			Steam Electric			Organic Chem & Pesticides			Inorganic Chem & Pesticides			Superfund Sites			POTW			Metal Discharging Industry			Other Industrial Categories			Miscellaneous Industries		
	Mainstem		Tribs	Mainstem		Tribs	Mainstem		Tribs	Mainstem		Tribs	Mainstem		Tribs	Mainstem		Tribs	Mainstem		Tribs	Mainstem		Tribs	Mainstem		Tribs
	Up	Down	Up	Up	Down	Up	Up	Down	Up	Up	Down	Up	Up	Down	Up	Up	Down	Up	Up	Down	Up	Up	Down	Up	Up	Down	Up
Region 3																											
CONTAMINATED																											
Juniata @ Newport, PA	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	6	-	-	2	-	-	-	-	-	2	-	-
Ohio @ Pike Island, WV	2	-	-	3	-	-	1	-	-	1	-	-	1	-	-	26	-	6	107	3	104	-	-	-	7	1	2
James @ Glasgow, VA	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	4	-	3	-	-	2	-	-	1	-	-	3
Shenandoah @ Rockland, VA	-	-	-	1	-	-	-	-	1	1	-	1	-	-	-	5	-	3	5	-	-	-	-	-	2	-	2
Potomac @ E. Potomac Park, DC	-	-	-	1	1	-	-	-	-	-	-	-	-	-	-	3	1	3	-	-	1	1	1	1	4	1	-
Potomac @ Shepardstown, MD	-	-	-	1	-	-	-	-	-	-	-	-	-	-	1	4	1	7	-	-	1	1	-	2	1	-	9
Allegheny @ New Kensington, PA	-	-	-	-	2	-	-	1	-	1	-	2	-	-	2	13	4	14	25	4	21	7	-	-	8	-	6
NONCONTAMINATED																											
Pennsylvania																											
Susquehanna @ Columbia	-	-	1	2	-	1	-	-	-	-	-	1	-	-	1	17	2	14	7	-	10	4	-	1	2	-	15
W. Br. Susquehanna @ Lewisburg	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	11	1	1	5	-	1	-	-	-	2	-	1
Monongahela @ Clairton	-	-	-	3	-	-	-	-	-	1	-	-	-	-	-	13	6	4	10	4	9	3	-	-	4	-	-
Allegheny @ Franklin	-	-	-	-	-	-	-	-	1	-	-	2	-	-	-	5	-	4	4	-	7	1	-	2	-	1	1
Young Women's Creek near Renovo	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
West Virginia																											
Little Kanawha @ Palestine	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2	2	-	-	1	-	-	1	-	-	1
Tygart Lake, Grafton	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	9	-	2	-	-	-	-	-	-
Kanawha @ Gauley Bridge	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	4	2	7	8	-	47	-	-	-	-	-	2
Guyandotte @ Salt Rock	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2	-	-	2	-	-	-	-	-	-	-	-
Shenandoah @ Meyerstown	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	1	-	-	-	-	-	-	-	-
Virginia																											
Nottoway near Sebrell	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2	-	-	1	-	-	-	-	-	-
James @ Cartersville	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	1	1	-	1	1	-	-
Holiday Creek near Andersonville	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Maryland																											
Patapsco @ Ellicott City	-	-	1	-	-	-	-	-	-	-	-	1	-	-	-	-	-	1	1	-	1	-	1	1	-	-	2
Delaware																											
Nanticoke @ Woodland	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	1	-	1	-	-	-	-	-	-	-	-	1
C&D Canal @ St. Georges	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Region 4																											
CONTAMINATED																											
Lake Hickory, Catawba River, NC	-	-	-	2	-	-	-	-	-	-	-	-	-	-	-	7	1	3	1	-	2	2	2	6	3	2	5
Pee Dee @ Peedee, SC	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	1	1	-	-	-
Ohio @ Markland Dam, KY	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	2	-	8	-	-	-	-	-	1	1	-	-
Ohio @ Cannelton Dam, KY	1	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	1	1	2
Kentucky @ Gest, KY	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1
Big Black near Bovina, MS	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-
Homochitto @ Rosetta, MS	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	3	-	1	1	-	-	1	-	-	-	-	-
Pascagoula near Benndale, MS	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	1
Coosa @ Childersburg, AL	1	-	-	1	-	-	-	1	-	-	-	-	-	-	-	2	-	6	1	-	4	-	-	3	-	-	3
Lake Murray @ Prosperity, SC	1^a	-	-	2^a	-	-	1^a	-	-	-	-	-	-	-	-	47^a	-	-	4^a	-	-	10^a	-	-	6^a	-	-
Alabama @ Claiborne, AL	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2	-	-	-	-	-	-	-	-	1
Tennessee @ Waterloo, AL	1^a	-	-	2^a	-	-	-	-	-	1^a	-	-	-	-	-	8^a	-	-	5^a	-	-	1^a	-	-	2^a	-	-
Savannah @ Augusta, GA	1	-	-	2	-	-	1	-	-	2	1	-	-	-	-	7	-	1	2	-	4	1	-	7	2	-	1
Flint River, Lake Blackshear, GA	-	-	-	1	1	-	-	-	-	-	-	-	-	-	-	-	-	2	-	-	-	-	-	-	-	-	-
NONCONTAMINATED																											
North Carolina																											
Pee Dee @ Hydro	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2	-	-	1	-	-	-	-	-	1	-	-
French Broad @ Marshall	-	-	-	1	-	-	-	-	1	-	-	-	-	-	-	8	-	2	1	-	1	1	-	2	1	-	2
Neuse @ Kinston	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2	1	1	-	-	-	-	-	-	1	2	2

APPENDIX D-11 (Continued)

SUMMARY OF INDUSTRIAL FACILITIES LOCATED NEAR REGIONALLY SELECTED TIER 7 FISH SAMPLING SITES

SITE NAME	Number of Facilities Located Near Sampling Sites*																										
	Pulp & Paper Mills			Steam Electric			Organic Chem & Pesticides			Inorganic Chem & Pesticides			Superfund Sites			POTW			Metal Discharging Industry			Other Industrial Categories			Miscellaneous Industries		
	Mainstem		Tribs	Mainstem		Tribs	Mainstem		Tribs	Mainstem		Tribs	Mainstem		Tribs	Mainstem		Tribs	Mainstem		Tribs	Mainstem		Tribs	Mainstem		Tribs
	Up	Down	Up	Up	Down	Up	Up	Down	Up	Up	Down	Up	Up	Down	Up	Up	Down	Up	Up	Down	Up	Up	Down	Up	Up	Down	Up
Region 4 (Continued)																											
NONCONTAMINATED (CONTINUED)																											
South Carolina																											
Lynches @ Effingham	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2	-	-	-	1	-	-	1	-	-
Edisto near Givhans	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	2	-	-	-	-	-	-	-	-	4
Lake Marion, Santee	1[a]	-	-	1[a]	-	-	-	-	-	-	-	-	-	-	-	2[a]	-	-	-	-	-	-	-	-	4[a]	-	-
Lake Wylie, Clover	1[a]	-	-	1[a]	-	-	2[a]	-	-	2[a]	-	-	-	-	-	35[a]	-	-	9[a]	-	-	17[a]	-	-	13[a]	-	-
Kentucky																											
Kentucky Lake, Tennessee River	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2[a]	-	-
Green near Beach Grove	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	3	-	1	8	1	5	-	-	-	1	-	1
Cave Run Lake, Licking River	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2[a]	1	-	16[a]	-	-	-	-	-	2[a]	-	-
Tennessee																											
Holston near Knoxville	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2	1	-	3	1	1	-	-	-	3	-	1
Hatchie @ Bolivar	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	1	-	-	1	-	-
Little Tennessee @ Tallassee	-	-	-	1	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Mississippi																											
Sardis Lake, Tallahatchie River	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	2	-	-	1	-	-	-	-	-	-
Alabama																											
Conecuh @ East Brewton	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Tombigbee @ Gainesville	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	1	-	-	-	-	-	-
Chattahoochee @ Eufaula	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	3	-	-	1	-	-	-	-	-	-	-
Choctawhatchee @ Geneva	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2	-	2	-	-	-	-	-	-	-	-	-
Georgia																											
Lake Sidney Lanier	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	16[a]	-	-	1[a]	-	-	7[a]	-	-	-	-	-
Hartwell Reservoir	-	-	-	4[a]	-	-	1[a]	-	-	-	-	-	-	-	-	23[a]	-	-	6[a]	-	-	20[a]	-	-	4[a]	-	-
Ogeechee near Eden	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Florida																											
St. Johns @ Palatka	-	-	-	2	-	-	-	-	-	-	-	-	-	-	-	2	-	1	-	-	-	-	-	-	-	-	-
Lake Monroe, St. Johns River	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	2	1	-	-	1	-	-	-	-	-	-	-
Lake Talquin, Talahassee	-	-	-	1[a]	-	-	-	-	-	-	-	-	-	-	-	2	-	-	-	-	-	-	-	-	1	-	-
Suwannee @ Branford	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Aucilla near Scanlon	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	3	-	-	-	-	-	-	-	-	-	-	-
Lake Parker @ Lakeland	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Region 5																											
CONTAMINATED																											
Mississippi @ Thebes, IL	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	1	-	5	1	-	-	1	-	-	1	-	2
Illinois @ Florence, IL	-	-	-	1	-	-	1	-	-	-	-	-	-	-	-	1	2	9	-	-	-	-	-	-	-	1	6
Illinois @ Marseilles, IL	1	-	-	4	-	-	1	1	2	1	-	-	-	-	-	3	-	7	-	-	1	-	-	-	-	-	2
Kaskaskia @ Vandalia, IL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	9	1	2	-	-	-	1	-	-	5	-	1
Des Plaines @ Lockport, IL	-	-	-	-	-	-	1	-	-	1	1	-	-	-	-	22	1	2	3	-	-	2	1	-	5	2	1
Wabash @ Black Rock, IN	1	-	-	1	-	-	1	-	-	-	-	-	-	-	-	8	-	1	2	1	1	1	-	1	2	-	-
Ohio @ Uniontown, KY	-	-	-	-	-	-	1	-	-	1	-	-	-	-	-	3	-	7	1	-	1	1	-	-	2	-	2
Ohio @ West Point, KY	-	-	-	3	-	-	4	-	-	1	-	-	2	-	-	12	-	2	6	-	1	4	-	1	16	-	3
Mississinewa @ Matthews, IN	1	-	1	-	-	-	-	-	-	-	-	-	-	-	-	5	1	3	1	-	-	-	-	-	5	2	3
Grand Calumet @ East Chicago, IL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-
Kalamazoo @ L. Allegan, MI	7	-	-	-	-	-	1	-	-	-	-	-	-	-	-	4	1	-	11	2	1	3	2	-	3	1	-
St. Clair @ Algonac, MI	1	1[a]	1	3	-	2	-	-	-	1	1[a]	1	-	2[a]	-	30[a]	-	7	26[a]	-	1	6[a]	-	1	32[a]	-	5
Clinton @ Mt. Clemens, MI	-	-	-	-	-	-	-	-	-	1	-	-	2	-	-	5	1	5	15	2	9	3	-	3	3	-	7
Pine @ Alma, MI	-	-	-	-	-	-	-	-	-	-	-	-	-	3	-	-	3	-	2	-	-	1	-	1	2	-	3
Rainy @ International Falls, MN	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2	-	-	-	-	-	-	-	-	1	-	-
Ohio @ East Liverpool, OH	-	-	-	7	-	1	-	-	2	-	-	1	-	-	-	10	4	16	16	-	54	3	-	-	8	4	8
Ohio @ Gallipolis, OH	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	2		4	2	-	1	-	-	-	1	2	

APPENDIX D-11 (Continued)

SUMMARY OF INDUSTRIAL FACILITIES LOCATED NEAR REGIONALLY SELECTED TIER 7 FISH SAMPLING SITES

SITE NAME	Number of Facilities Located Near Sampling Sites*																										
	Pulp & Paper Mills			Steam Electric			Organic Chem & Pesticides			Inorganic Chem & Pesticides			Superfund Sites			POTW			Metal Discharging Industry			Other Industrial Categories			Miscellaneous Industries		
	Mainstem		Tribs	Mainstem		Tribs	Mainstem		Tribs	Mainstem		Tribs	Mainstem		Tribs	Mainstem		Tribs	Mainstem		Tribs	Mainstem		Tribs	Mainstem		Tribs
	Up	Down	Up	Up	Down	Up	Up	Down	Up	Up	Down	Up	Up	Down	Up	Up	Down	Up	Up	Down	Up	Up	Down	Up	Up	Down	Up
Region 5 (Continued)																											
CONTAMINATED (CONTINUED)																											
Scioto @ Circleville, OH	-	1	-	7	-	-	-	1	-	2	-	-	1	-	-	12	-	14	3	1	2	1	-	1	11	2	4
Ohio @ Marietta, OH	-	-	-	2	-	1	1	-	1	1	-	-	-	-	-	8	-	6	1	-	6	3	-	3	3	-	3
Ohio @ Portsmouth, OH	-	-	-	-	-	-	1	-	-	1	-	-	-	-	-	8	2	2	4	-	5	-	-	-	2	5	7
Great Miami @ Franklin, OH	6	1	-	4	-	-	-	-	-	-	-	-	-	-	-	11	6	3	6	1	5	2	-	2	14	-	5
St. Croix @ St. Croix Falls, WI	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-
Black @ Black River Falls, WI	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	1	2	1	-	-	-	-	-	1	-	-
Muskegon Lake, MI	1a	-	-	1	-	-	-	-	-	-	-	-	1a	-	1	4a	-	-	6a	-	2	1a	-	-	5a	-	-
Flint @ Elms Road, MI	-	-	-	1	-	-	-	-	-	-	-	-	-	-	1	2	-	2	2	1	4	-	-	-	2	-	4
Great Miami near Hamilton, OH	7	-	-	2	-	-	1	-	-	-	-	-	-	-	-	10	2	7	5	-	1	-	1	1	8	1	8
NONCONTAMINATED																											
Illinois																											
Big Muddy @ Grand Tower	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	6	-	-	-	-	-	-	-	-	2	-	-
Rock @ Joslin	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	5	-	2	-	-	1	-	-	-	-	-	-
Indiana																											
Wabash @ Darwins' Ferry	1	-	-	2	-	-	1	-	-	2	-	-	-	-	1	2	-	3	-	-	4	2	-	1	2	-	2
White @ Petersburg	-	-	-	2	-	-	-	-	-	-	-	-	-	-	-	4	-	1	4	1	3	-	-	-	2	-	-
Michigan																											
Shiawassee @ Chesaning	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	4	-	-	5	-	-	-	-	-	3	-	2
River Raisin @ Monroe	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	3	-	3	-	-	-	-	-	-	4	-	3
Huron @ Flatrock	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	7	-	3	7	-	-	-	-	-	1	-	5
Muskegon @ Rogers Dam	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	1	-	1	3	-	-	-	-	-	-	-	1
AuSable @ Mio	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	1	-
Minnesota																											
Mississippi @ LaCrosse	-	-	-	1	2	1	-	-	-	-	-	-	-	-	-	4	2	5	-	-	4	-	1	1	1	1	4
Minnesota @ Mankato	-	-	-	1	1	-	-	-	-	-	-	-	-	1	-	2	2	5	-	-	-	-	-	-	3	-	12
Cannon Lake @ Faribault	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2	-	-	-	-	-	-	-	-	2	-	-
Ohio																											
Muskingum @ Zanesville	-	-	1	1	-	-	-	-	-	-	-	-	1	-	-	15	-	3	10	1	5	1	-	-	6	-	3
N. Fk. Little Beaver Cr. @ Damascus	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	2	-	1	-	-	-	4	-
Wisconsin																											
Wisconsin @ Boom Bay	3	-	-	1	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-
Fox @ Waukesha	-	-	-	-	-	-	1	-	1	-	-	-	1	-	-	7	1	1	16	-	-	1	-	-	3	-	3
Wisconsin @ Biron Flowage	4	3	-	2	1	-	-	-	-	-	-	-	-	-	-	4	1	2	1	-	-	-	-	-	4	-	-
Region 6																											
CONTAMINATED																											
Lake Houston - San Jacinto R, TX	-	-	-	-	-	-	4a	-	-	2a	-	-	5a	-	-	125a	-	-	1a	-	-	-	-	-	6a	-	-
Mississippi @ St. Francisville, LA	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Bayou Lafourche, LA	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	5	-	-	-	-	-	1	-	-	1	1	-
NONCONTAMINATED																											
Texas																											
Brazos near Clear Fork	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-
Concho @ Paint Rock	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	1	1	-	-	-	-	-	-	-	1	-
Louisiana																											
Toledo Bend Reservoir	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	11	-	-	-	-	-	-	-	-	-	4	-
Ouachita @ Jonesville	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	1	-	-	-	-	-	-	-	-	-	-
Vermillion	-	-	-	1b	-	-	1b	-	-	-	-	-	-	-	-	28a	-	-	2a	-	-	4a	-	-	10a	-	-
Calcasieu @ Calcasieu Lake	-	-	-	2	-	-	4	-	1	4	-	1	1	-	-	10a	-	2a	2a	-	-	10a	-	-	8a	-	1a
Lake Borgne																1a						2a					

APPENDIX D-11 (Continued)

SUMMARY OF INDUSTRIAL FACILITIES LOCATED NEAR REGIONALLY SELECTED TIER 7 FISH SAMPLING SITES

SITE NAME	Number of Facilities Located Near Sampling Sites[a]																										
	Pulp & Paper Mills			Steam Electric			Organic Chem & Pesticides			Inorganic Chem & Pesticides			Superfund Sites			POTW			Metal Discharging Industry			Other Industrial Categories			Miscellaneous Industries		
	Mainstem		Tribs	Mainstem		Tribs	Mainstem		Tribs	Mainstem		Tribs	Mainstem		Tribs	Mainstem		Tribs	Mainstem		Tribs	Mainstem		Tribs	Mainstem		Tribs
	Up	Down	Up	Up	Down	Up	Up	Down	Up	Up	Down	Up	Up	Down	Up	Up	Down	Up	Up	Down	Up	Up	Down	Up	Up	Down	Up
Region 6 (Continued)																											
NONCONTAMINATED (CONTINUED)																											
Oklahoma																											
Arkansas @ Van Buren	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	4	-	2	4	-	-	1	-	-	3	-	-
Cimarron @ Perkins	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-
Canadian @ Eufaula	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	6[a]	-	-	1[a]	-	-	-	-	-	4[a]	-	-
Arkansas																											
White @ Clarendon	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	1	3	-	-	-	-	-	-	-	1	1
L'Anguille @ Marianna	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	3	2	-	-	1	-	-	-	-	-	-	-
St. Francis @ Madison	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
New Mexico																											
Elephant Butte Reservoir	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-
Pecos @ Red Bluff	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
San Juan @ Shiprock	-	-	-	-	-	2	-	-	-	-	-	-	-	-	-	1	1	-	2	-	2	1	-	-	-	-	-
Gila @ Redrock	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Region 7																											
CONTAMINATED																											
Arkansas near Derby, KS	-	-	-	2	-	2	-	-	-	-	-	-	-	-	1	1	2	3	2	-	-	-	-	-	-	-	1
Neosho near Chetopa, KS	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	2	-	3	-	-	4	-	-	-	-	-	2
Tuttle Cr. Res., KS	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-
Missouri near Lexington, MO	-	-	-	1	-	1	-	-	-	-	-	-	-	-	-	-	-	4	-	-	-	-	-	-	-	-	-
Little R. Ditches @ Hornersville, MO	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	1	-	-
St. Francis near Cardwell, MO	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	4	-	-	-	-	-	-	-	-	-	-	-
Big Sioux @ Akron, IA	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-
NONCONTAMINATED																											
Nebraska																											
Platte @ Grand Island	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
North Platte @ McGrew	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	1	-	-	-	2	-
Little Blue @ Deweese	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1
Iowa																											
South Skunk below Ames	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	2	1	-	1	-	-	-	-	-	-
Kansas																											
Smoky Hill @ Enterprise	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	1	1	-	-	-	-	-	-	-	-	1
Missouri																											
Missouri @ Hermann	-	-	-	3	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	1	-	-	-	-	-
Grand @ Bosworth	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	1
Meramec near St. James	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-
Region 8																											
CONTAMINATED																											
Red R. of North @ Pembina, ND	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2	-	-	-	-	-	-	-	-	-
NONCONTAMINATED																											
North Dakota																											
Sheyenne near Kindred	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Heart @ Mandan	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Knife near Hazen	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	3	-	-	-	-	-	-
Souris near Upham	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

APPENDIX D-11 (Continued)

SUMMARY OF INDUSTRIAL FACILITIES LOCATED NEAR REGIONALLY SELECTED TIER 7 FISH SAMPLING SITES

SITE NAME	Number of Facilities Located Near Sampling Sites*																										
	Pulp & Paper Mills			Steam Electric			Organic Chem & Pesticides			Inorganic Chem & Pesticides			Superfund Sites			POTW			Metal Discharging Industry			Other Industrial Categories			Miscellaneous Industries		
	Mainstem		Tribs	Mainstem		Tribs	Mainstem		Tribs	Mainstem		Tribs	Mainstem		Tribs	Mainstem		Tribs	Mainstem		Tribs	Mainstem		Tribs	Mainstem		Tribs
	Up	Down	Up	Up	Down	Up	Up	Down	Up	Up	Down	Up	Up	Down	Up	Up	Down	Up	Up	Down	Up	Up	Down	Up	Up	Down	Up
Region 8 (Continued)																											
NONCONTAMINATED (CONTINUED)																											
South Dakota																											
James near Scotland	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Cheyenne @ Cherry Creek	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Wyoming																											
North Platte @ Orin	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	1	-	-	-	-	-
Shoshone @ Kane	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2	-	-	-	-	-	-	-	-	-
Green near Green River	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	1
Snake near Alpine	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-
Laramie above Howell	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	1	-	-	-	-	-	-	-	-	-	-	-
Colorado																											
Rio Grande near Labatos	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Arkansas near Barton	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-
South Platte @ Julesburg	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1
Gunnison near Grand Junction	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-
South Platte @ Littleton	-	-	-	-	-	-	-	-	-	1	-	1	-	-	-	1	-	1	-	-	1	-	-	-	1	-	1
Region 9																											
NONCONTAMINATED																											
California																											
Smith near Crescent City	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-
Sacramento @ Hood	-	-	-	-	-	-	1	-	-	-	-	-	1	-	-	10	-	1	1	-	1	-	-	-	3	-	1
Merced @ Happy Isles Bridge	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Lake Tahoe (head of Truckee River)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1^{a}	-	-	-	-	-	-	-	-	-	-	-
Arizona																											
Colorado near Martinez	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Gila near Yuma	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Verde @ Bartlett Dam	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Gila @ Edon	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Roosevelt Lake	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	5^{a}	-	-	6^{a}	-	-	-	-	-	-	-	-
Region 10																											
NONCONTAMINATED																											
Washington																											
Skagit near Mount Vernon	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Chehalis @ Porter	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Nisqually @ McKenna	-	-	-	2	-	-	-	-	-	-	-	-	-	1	-	2	-	1	-	-	-	-	-	-	-	-	-
Pend Oreille @ Dalkena	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	3	-	-	-	-	-	-	-	-	-	-	-
Spokane @ Long Lake	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2	-	-	-	-	-	-	-	-	-	-	-
Snake @ Tucannon	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Moses Lake @ Altmet	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	3^{a}	-	-	-	-	-	-	-	-	-	-	-
Oregon																											
Willamette @ Salem	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	4	-	3	-	-	1	-	-	-	-	-	3
Umpqua near Elkton	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-
McKenzie near Coburg	2	-	-	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2	-	-
Santiam @ Jefferson	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2	-	1	-	-	-	-	-	-	2	-	-
Deschutes near Moody	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Minam @ Minam	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
John Day @ McDonald Ferry	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Rogue below Grants Pass	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	4	-	-	-	-	-	-	-	-	4	-	1

APPENDIX D-11 (Continued)

SUMMARY OF INDUSTRIAL FACILITIES LOCATED NEAR REGIONALLY SELECTED TIER 7 FISH SAMPLING SITES

SITE NAME	Number of Facilities Located Near Sampling Sites*																										
	Pulp & Paper Mills			Steam Electric			Organic Chem & Pesticides			Inorganic Chem & Pesticides			Superfund Sites			POTW			Metal Discharging Industry			Other Industrial Categories			Miscellaneous Industries		
	Mainstem		Tribs	Mainstem		Tribs	Mainstem		Tribs	Mainstem		Tribs	Mainstem		Tribs	Mainstem		Tribs	Mainstem		Tribs	Mainstem		Tribs	Mainstem		Tribs
	Up	Down	Up	Up	Down	Up	Up	Down	Up	Up	Down	Up	Up	Down	Up	Up	Down	Up	Up	Down	Up	Up	Down	Up	Up	Down	Up
Region 10 (Continued)																											
NONCONTAMINATED (CONTINUED)																											
Idaho																											
American Falls Reservoir, Snake R.	-	-	-	-	-	-	-	-	-	1[a]	-	-	2[a]	-	-	1[a]	1	-	-	1[a]	-	1[a]	-	-	2[a]	-	-
Snake @ Burley	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2	-	-	-	-	-	-	-	-	-	-	-
Salmon @ Whitebird	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	1	-	-
Clearwater @ Spalding	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	6	-	-	-	-	-	-	-	-	-
Snake near Heise	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Alaska																											
Salcha near Salchaket	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	3[a]	-	-	-	-	-	1[a]	-	-	-	-	-
Kenai @ Soldotna	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2[a]	-	-	4[a]	-	-	17[a]	-	-	4[a]	-	-

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[a] These sites are within a 30 miles radius of the dioxin site.

*The facilities summarized are located within 3 miles downstream on the mainstem or 30 miles upstream on the mainstem and tributaries of the Tier 7 Fish Sampling site. The industrial catgeries include the facilities in the following SIC codes:

- Pulp and Paper - SIC 2611, 2621, 2631, 2641, 2642, 2643, 2645, 2646, 2647, 2648, 2649, 2651, 2652, 2653, 2654, 2655, and 2661
- Steam Electric - SIC 4911 and 4931
- Organic Chemicals, Plastics, and Synthetic Fibers and Pesticides Manufacturers SIC 2821, 2823, 2824, 2865, and 2869.
- Inorganic Chemicals and Pesticides Manufacturers - SIC 2812, 2813, 2816, and 2819
- Superfund Sites - SIC 8999.
- POTWs - SIC 4952 and 4954
- Metal Discharging Industry - Includes all facilities identified in the following industrial categories: Aluminum Forming, Battery Manufacturing, Coal Mining, Coil Coating, Foundries, Iron & Steel, Metal Finishing, Nonferrous Metals, Ore Mining, Paint, Porcelain Enameling, Copper Forming, Ink, Auto and Other Laundries, Photographics, and Electrical Components
- Other Industrial Categories - Includes all facilities identified in the following industrial categories: Leather Tanning, Textiles, Timber, Pharmaceuticals, Petroleum Refining, Misc. Chemicals, Argicultural Chemicals, Misc. Petroleum Products.
- Miscellaneous Industries - Includes all the remaining industrial categories, such as food products, lumber, Real Estate.